

ELECTRONICS

Australia

with CB and HIFI NEWS

JULY, 1977

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THIEF ALARM
• HOW TELECOM
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• NEW LOGIC
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- Arm pipe and shell made of carbon fibre suppresses resonant feedback.
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- Photo-electric sensor for disc-end eliminates mechanical impact.
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Features:

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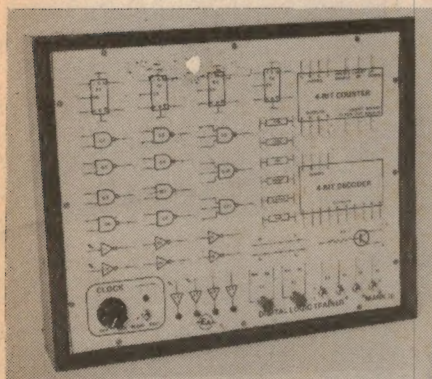
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We think readers will be as enthusiastic about our new digital logic trainer as we are. It is far more versatile than any of our previous designs, yet is lower in cost and far easier to build. Full constructional details commence on page 44.

Dick Smith—EA computer contest

Would you like to win a complete micro-computer system valued at over \$2000? You could if you can come up with a really ingenious application for Mini Scamp. The details are on page 74.

Great projects

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- Easy-to-build dwell meter for auto tune-ups/36
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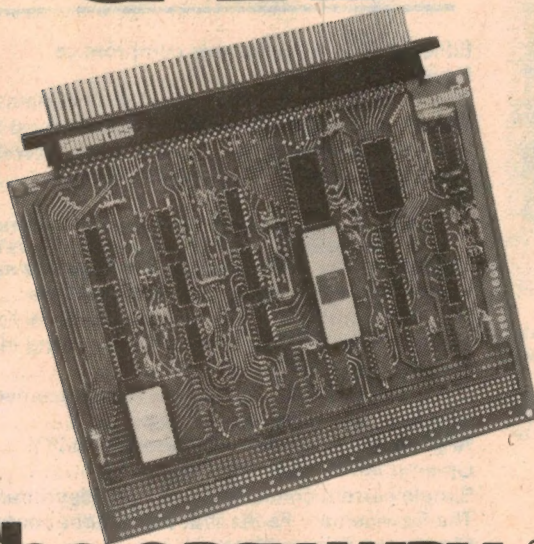
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On the cover

Our cover picture this month was taken at the Microcomputer Users Centre at Warburton Franki's plant in Auburn, NSW. At the centre engineers, technicians, and others interested in microcomputers can gain valuable "hands-on" experience with Intel systems, and develop application programs. (Picture courtesy Warburton O'Donnell Ltd).

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Editorial Viewpoint

CB: a reasonable compromise

As I write this, the Minister for Post and Telecommunications has just announced the Government decision to legalise Citizen Band radio. Only the broad outline of the decision has been worked out at this stage, but I am told by the P and T Department's 1st Assistant Secretary Mr E. J. Wilkinson that he expects equipment specifications and licensing conditions and procedures to be announced by the time you read this early in July, or very shortly afterwards.

Bearing in mind the events which have led up to the decision, the plan as outlined seems to me to be a reasonable and realistic one, with a logical balance between short-term expediency and long-term planning goals.

For example, by allowing for the licensing or type approval of new 27MHz equipment until June 1982, and then maintaining approval for existing 27MHz equipment for a reasonable period thereafter, it should ensure that citizens have adequate opportunity to take advantage of currently available equipment. Similarly, by not trying to prohibit AM gear, it will allow those who have invested in this equipment to obtain a reasonable working life from it. It will also allow others to gain some experience of CB radio at a low initial cost.

On the other hand the decision seems to reflect a realistic approach towards the long-term goal of shifting CB activity into the UHF region. By allowing parallel operation on 27MHz for what may well become a period of eight to ten years, it ensures that CB will not be delayed until suitable UHF equipment is developed. But by providing for UHF licensing right from the start, the decision gives adequate impetus to the development and/or importation of suitable gear.

I believe it is almost certain that we will be adopting the same UHF frequency allocations and performance specifications as those adopted by the USA. So that there should be every opportunity for a healthy market situation, where locally manufactured equipment and imported equipment can both compete. Hopefully this together with advancing technology should ensure that by the time CB has finally moved over into the UHF band, the equipment should cost no more in relative terms than current 27MHz gear.

In short, it seems to me that the Government and its P and T Department are coming up with a fair and realistic response to the demand for legalised CB radio, one which deserves the support of all reasonable people.

If it gets that support, I believe it stands a good chance of avoiding many of the problems which have been encountered overseas.

Of course not everyone will find the compromise an attractive one. Radio amateurs will understandably be unhappy about the influx of CBers on 27MHz during the parallel operation period. It is to be hoped that at least they will not be denied access to the band during this period, and will retain access when CB moves on.

—Jamieson Rowe

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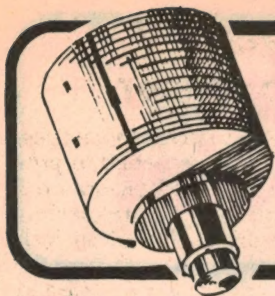
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News Highlights



New Ferranti ULAs save time—and money!

The basic reason for the introduction of large scale integration (LSI) of electronic circuitry is its cost effectiveness. Extremely complex designs can be mass produced quickly and economically.

The two routes most commonly considered to achieve LSI solutions to demanding circuit design problems are custom design and the microprocessor. Each has its merits.

Custom design will invariably provide the most economic solution for large volumes, but has the disadvantage of high development cost and long lead time. And if a major modification is required, costs and lead time can escalate rapidly.

Microprocessors, on the other hand, offer the advantage of lower development cost and shorter lead time. However, a large number of additional IC packages are often required to turn the microprocessor into an operational system. Thus it can become a bulky and expensive solution for many large volume LSI requirements.

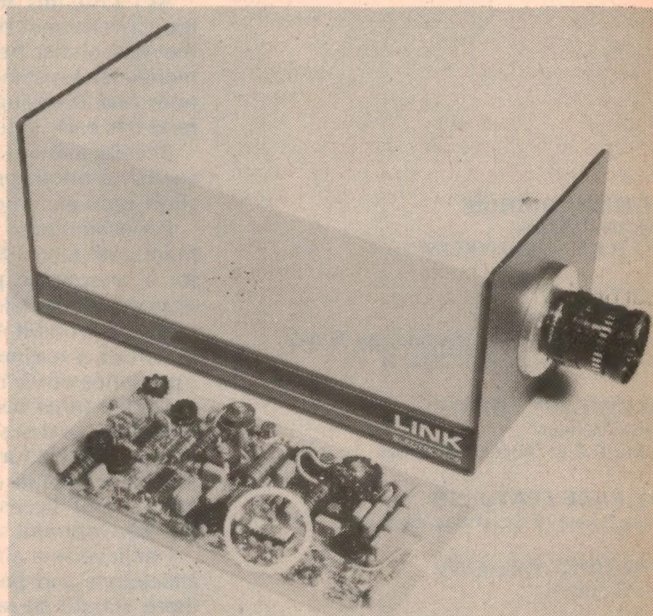
For many design problems then, the ideal solution would be to combine the advantages of custom design—optimum performance, chip size and manufacturing economy—with the microprocessor's lower development cost and shorter lead time.

The Ferranti family of three bipolar logic arrays is one answer to the problem. These arrays are basic building blocks in which a great deal of the device has been built up but the final decision on functions is left to the user.

The arrays are fabricated using Ferranti's CDI process. The wafers are held in stock with their processing four-fifths completed. Both the supply and earth return current paths are routed through the semiconductor material. A single customising metal interconnection mask has then to be applied for logic and circuit connections.

Each array has 225 identical cells which consist of three transistors and five resistors arranged in a regular matrix, with peripheral interface components and 40 fixed bond pad positions. Component geometrics and topographical structures of all three arrays are identical except for differences in the cell resistor values. This has two important implications.

First, processing is rationalised because the arrays share common diffusion masks and processing steps. Second, there is a high degree of interchangeability of circuit and logic



An uncommitted logic array element is employed by Link Electronics in this closed-circuit television system.

designs between the arrays, and a metal interconnection mask for one array can often be used on another to give different operating characteristics.

Within this rationalised array family concept the different cell resistors produce custom circuits with characteristics covering a range of system requirements. The arrays are differentiated by their titles: low-power, standard and high speed array.

A library of fully characterised circuit functions includes logic functions such as gates and flip flops, interface circuits for TTL/CMOS, Schmitt triggers and discrete components, LED and triac drivers and other important system functions such as oscillators, monostables and amplifiers.

Life's not easy for the British Post Office

In a £9 million Post Office project giving Britain the world's largest telephone cable, engineers had to dam a river, tunnel under railways and motorways—and even hire an aircraft to locate old mine workings. Work on the cable's southern section is now under way in London.

A high degree of engineering skill was called for in preparing the route for the new cable, which runs 383km to link London, Reading, Birmingham and Manchester.

Capable of carrying nearly 100,000 phone calls at once, the cable will form a new high-capacity backbone for one of

Britain's most valuable assets—its £10,000 million telecommunications network.

In laying the duct for the cable, construction workers:

- dammed the River Brent at Hanwell to enable a trench to be dug across the river bed;
- opened a disused gas main at Uxbridge to take the cable under a busy roundabout without disrupting traffic;
- drove a tunnel under the River Wye at High Wycombe, through gravel which continually seeped water; and
- hired an aircraft to check moorland near Buxton for unmapped mineshafts in

the cable's path.

Companies responsible for the supply and installation of the giant cable were Standard Telephones and Cables Ltd, Pirelli General Cables Ltd, Telephone Cables Ltd and British Insulated Callenders Cables Ltd.

The new cable has 18 air-insulated coaxial tubes of 9.5mm diameter, with a 2.6mm inner conductor, creating what is called a coaxial pair.

Two coaxial pairs in the new cable—one in each direction of transmission—can carry up to 10,800 phone calls at once, or an equivalent mix of telephone calls, telex messages, television and sound broadcasts and computer data.

CB—it's legal!

After months of speculation, CB radio has finally been made legal. Government approval for introduction of the service on both UHF and 27MHz bands, came in a broad policy decision on June 3, just as this issue was about to go to press.

Announcing the government's decision, the Minister for Post and Telecommunications, Mr Eric Robinson, said that CB enthusiasts now had the opportunity to become legal operators using existing 27MHz equipment. Conditions for using CB equipment and licensing procedures are expected to be announced as soon as possible.

An annual licence fee of \$20.00 is also expected to be announced, although official confirmation of this figure has yet to be made.

Central to the government's new policy on CB will be the eventual phasing out of the 27MHz band in favour of UHF. Licences will be issued to all newly purchased equipment, both 27MHz and UHF, until June 1982, after which new licences will be issued for UHF equipment only. It will still be legal to operate existing 27MHz gear after June 1982 though, and licence renewals will be made after this date.

For enthusiasts, then, the transition from 27MHz to UHF should be relatively painless. What the government's decision simply means is that no new 27MHz gear will be added to the CB service after June 1982. The result of this should be a gradual phasing out of the 27MHz band over a period of some ten years as equipment becomes obsolete.

An important factor in the transition to UHF is the decision to license UHF equipment from the start. UHF standards will be set so as not to make Australia isolationist with respect to other markets, and will conform to American UHF standards. American UHF gear will be suitable for use in Australia, and will be licensed.

Because of the significant technical advantages offered by UHF, it is expected that operators will quickly change over to it as soon as equipment becomes available at reasonable cost.

Advantages cited for the UHF band include flexibility in channel allocation and reduced risks of interference to other electronic equipment, such as radio and TV receivers, and audio equipment. In addition, the shorter range of UHF would reduce mutual interference between groups of operators on the same channel.

The government is also reported to be anxious that Australian manufacturers be given every opportunity to compete on the CB market. Some manufacturers will doubtless be grateful for the opportunity as colour TV sales begin to wind down, although for the public local manufacture could mean higher prices.

Flat screen TV one step closer

Westinghouse Research Laboratories, Pittsburgh, USA, has succeeded in producing an off-air television picture on a thin-film transistorised electroluminescent panel only one eighth of an inch thick.

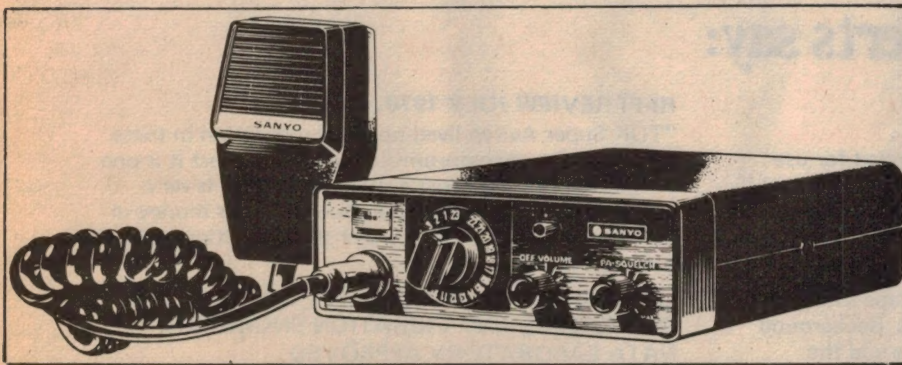
The picture was in black and white and at a definition of about 30 lines per inch but was described by Dr. T. P. Brody, head of the research group involved, as of "good quality" with no visible flicker or smear, even for rapidly moving objects.

The panel, six inches square, was originally developed by Westinghouse for a digital alphanumeric display. However, it was realised that the micro-miniature thin-film transistors that control the brightness of the elements were also capable of grey scale operation. Researchers were surprised at the result of a subsequent attempt to feed video to the panel and are now working on a new 5 x 3½ inch screen which will have 262 lines and 80,000 elements.

The panel is in effect a very large integrated circuit with a 110 x 110 (=12,100), element format. Each element consists of two thin-film transistors, a capacitor and phosphor overlay material. There is still a long way to go to match current monochrome definition, however—some 250,000 elements would be needed, and for colour the element count would be trebled.

The company is now looking at the colour prospects although, according to Brody "several more years" of concentrated effort will be needed to arrive at something comparable with a modern colour tube.

... and there's no shortage of quality gear at reasonable cost



Anticipating the legalisation of CB radio, Dick Smith Electronics took delivery last May of nearly a quarter of a million dollar's worth of these 23-channel Sanyo transceivers. In fact, their arrival created a bit of a problem for Dick. The sets arrived packed in a huge steel shipping container, and try as he might the driver was unable to manoeuvre the load into the unloading dock of Dick's Artarmon warehouse. But the good news is that Dick is selling these "famous brand" CB rigs for just \$99.50, the first time that a famous brand has been able to break the magic \$100.00 barrier.

Microprocessor conference

A conference and workshop on microprocessors and their impact on computing is to be held at the Canberra College of Advanced Education, on September 18th and 19th. The conference is being organised jointly by the CCAE and the Australian Computer Society, and is hoped to attract computer hobbyists as well as professionals. Activities will include talks by invited speakers, open discussions and hands-on sessions with various microcomputer systems and hardware.

Registration fees have been held low, to make the conference as attractive as possible for non-professionals paying their own way. Fees are \$15 for ACS members, and \$20 for non members.

Further information is available from Sandra Harding or Dr Bill Caelli on 062 47 0544, or Brian Stone on 062 52 2418.

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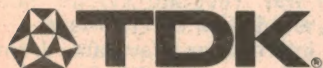
"Listening tests proved that Super Avilyn tape sounds as good as its measured performance indicates. Background noise is substantially lower than other tapes and the dynamic range is unquestionably better. Frequency response is excellent."

HI-FI REVIEW JULY 1976

"TDK Super Avilyn lived up to its reputation in these tests. For the uncompromising tape enthusiast it is one of the best cassette tapes available. Its price is very competitive making this tape good value for money in the high performance range. For the perfectionist, TDK's hard to beat."

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NEWS HIGHLIGHTS

HMV takes a colour TV set stunt flying



Colour TV advertisements by EMI (Australia) Ltd, who make HMV colour sets, are different to say the least. Last year, they showed a 43cm set operating on a speedboat travelling at high speed and a 53cm set working on an armoured military vehicle bumping over rough terrain and rock. Their latest ad shows a HMV 48cm set fixed under the wing of a light aircraft. The purpose of the ads—to demonstrate the reliability and stability of the self-converging picture tube used in HMV sets under extreme conditions. According to EMI, public response to the ads has been dramatic.

Viking spacecraft out in the cold

Viking Lander 2, the second US spacecraft to soft-land on Mars, is now in the grip of the Martian winter.

Temperatures at Utopia Planitia, where Viking Lander 2 landed on September 3, 1976, are now at the frost point of carbon dioxide. This temperature, -123 degrees Celsius (-190 degrees Fahrenheit) compares with daily highs of -31 to -34 degrees C (-25 to -30 degrees F) recorded earlier. Viking was not designed to operate at such a low temperature.

From April 8 through 14 a series of commands were sent to Viking Lander 2 to collect reduced scientific information. All remaining power will run heaters in an attempt to maintain survivable temperatures inside the Lander until the Martian spring (about mid-October).

As long as sunlight shines strongly on the Martian surface and no frost forms, temperatures remain above the frost point of carbon dioxide. But when an overnight layer of ice forms, it reflects much of the early-morning sunlight back to space; surface temperatures then fall rapidly.

High altitude water-ice clouds and atmospheric dust help screen out sunlight, accelerating the temperature plunge below operating levels.

The severe winter cold is expected to have little effect on Viking Lander 1, which landed nearer to the Martian equator.

Westinghouse in solar energy experiment

Westinghouse Electric Corporation's advanced energy systems division in the US will serve as project integrator for the US Energy Research and Development Administration's (ERDA) solar total energy large-scale experiment. ERDA has announced selection of a team headed by Georgia Power Company, with Westinghouse as one subcontractor, to carry out the \$US20 million experiment.

To be built at Shenandoah, Georgia, 40kms southwest of Atlanta, the solar energy system will supply electricity, industrial process heat, and space heating and cooling for a new knitwear factory. As project integrator, Westinghouse will co-ordinate the activities of participants in the experiment and will be responsible for analysing the performance of the system.

The solar system is expected to provide 60 to 90 percent of all the energy needed for the knitwear factory. It will produce a maximum of 200-500kW of electricity and approximately 1.3MW of thermal energy, depending upon final design decisions. The rest of the energy will be provided from traditional sources,

including power from Georgia Power Company.

In preliminary project designs, the solar system consists of approximately five acres of solar collectors to concentrate the Sun's rays on moveable pipes containing a heat-absorbing oil. The pipes are to move as the Sun moves so that they receive the maximum amount

of heat available from the solar collectors.

Heated to about 600 degrees F, the oil will be used to produce steam to drive a turbine to generate electricity. Exhaust heat from the turbine will be piped into the knitwear factory to heat or cool the building and to provide steam for pressing the clothing manufactured there.

Construction of the experimental facility is expected to begin in 1979, with completion scheduled in 1981.

Pat Daly is Marketing Manager for Dick Smith

Dick Smith Electronics Pty Ltd has appointed Mr Pat Daly as Marketing Manager. This is a new appointment within the Dick Smith Electronics Group, and reflects the growth of this Sydney-based company.

Pat Daly is well known in the Electronics Industry, and was previously Sales Manager for Parameters Pty Ltd. His expertise in sales promotion and marketing is considered significant by Dick Smith Electronics in view of the recent legal introduction of CB radio



into Australia, and moves by the Dick Smith Electronics Group to import consumer electrical equipment.

Pat Daly will be based at the Sydney headquarters of Dick Smith Electronics, 24 Carlotta St, Artarmon, NSW 2064. Telephone 439 5311.

Power cables—research looks at the problems

Short circuits in power cables can result in economic loss to electrical generating and transmitting companies, as well as inconvenience and expense to business, industry and the general public. In Canada, the National Research Council has devised methods of accelerating the mechanisms of cable breakdown, so as to provide reliable estimates of operational life and to help with the search for better insulating materials.

The laying of power cables is a costly business involving excavations and disruptions of power to homes, offices and factories. But once laid, the cable is expected to remain intact for 40 years.

A problem arises when a cable manufacturer wishes to introduce a new manufacturing process or new materials. The lifetime of an existing cable may be 40 years, but what does a cable manufacturer do to establish the life expectancy of a new cable? To test the new process or material over a 40-year span is clearly impracticable. Instead the manufacturer seeks an authoritative test of the lifetime of his cable that can be performed in months rather than years.

Studies and tests by the National Research Council of Canada (NRC) have uncovered methods of accelerating the

various mechanisms which lead to cable breakdown and providing manufacturers with a reliable estimate of operational life.

Dr John Densley of NRC's electrical engineering division developed the accelerated testing methods for power cable insulation. Dr Densley made an extensive study of the properties of solid insulation used in electrical power transmission so as to design the series of accelerated tests, which will yield an accurate measure of the lifetime of the insulation in a power cable.

A modern power cable consists of a central conductor which carries the high voltage current, covered by insulating material which, in turn, is surrounded by the second conductor. In cable manufacture, the insulating material (generally

composed of cross-linked polyethylene) is extruded in a molten form onto the central copper conductor and it is at this point that defects may develop which can lead to failure several years later.

Any insulation breaks down under sufficiently high electrical stress, which occurs when a voltage is applied over a thickness of insulation and increases as the voltage is raised or the thickness of insulation decreased. Each insulating material has a characteristic breaking point at which the electrical stress is so great that the insulation fails.

Modern power cables can withstand stresses many times greater than their normal loadings, up to millions of volts, for short periods of time. But the same cable under normal stresses may break down after only a few years of service. This problem of weakening by ageing in cable insulation has been traced by Dr Densley to causes that range from defects introduced during manufacture to the effects of the cable's environment.

For example, during the extrusion of the insulation on the central conductor, small voids of gas form. Under normal electrical stresses, sparks can occur within these voids and eat away at the surrounding material. The sparks, or partial discharges, burrow through the insulation at each peak of the applied voltage. Total breakdown occurs after several years' service.

The voids, which can be controlled by careful manufacturing processes, continue to be of interest to Dr Densley. "With the shortage of materials becoming acute in the future, we must look to the day when cable insulation is much thinner," Dr Densley says. "Thinner insulation will give rise to increased electrical stress and we believe that, at some critical value, failure due to microvoids will occur. Microvoids are extremely small cavities which are always present in polymers but, up to now, have not caused electrical problems since normal



Left: Dr Densley in the laboratory. His research is providing valuable data in the search for improved insulating materials for long-life power transmission cables.



Insulation breakdown can result after many hours of electrical stress under arduous test conditions. The above photograph shows electrical discharge at the tip of a metal needle which has been placed in the insulating material.

electrical stresses are insufficient to cause partial discharge.

"With the possibility of thinner insulations and higher electrical stresses in the future, we are bound to run into problems. Partial discharges in microvoids are very difficult to detect and measure so we are investigating the characteristics of partial discharge in thin insulations in which we have created artificially a known number of microvoids."

Another cause of electrical breakdown is the growth of 'electrical trees'. An electrical tree begins its life at a point of unusually high stress in an otherwise normally stressed cable. Such a point is associated with any small metallic impurity which has become embedded in the insulation during manufacture. At the tip of this metal sliver, the electrical field exceeds the natural strength of the insulation and a local breakdown takes place. From the rupture that results at the tip of the defect, an electrical tree can grow by the mechanism of partial discharge.

Dr Densley has investigated the effect of different parameters, such as temperature, voltage, frequency and mechanical stress upon the processes which lead to insulation breakdown. With the aid of this data he is developing reliable accelerated ageing tests. As an example, electrical discharge within a void occurs at each peak of a voltage cycle.

Normal power transmission in Canada takes place at 60Hz but if a cable is tested at 600Hz it will age 10 times faster as a result of this destructive mechanism. Additional factors are also considered in such a test, such as application of eleva-

ted temperatures and mechanical stresses. In this fashion, a particular cable insulation could be comprehensively tested in six to 10 months.

Dr Densley's research is not without occasional surprises. A cable was brought to him which had been laid in a waterlogged location and failed after only two years in service. Since polyethylene is considered impervious to water, the location was at first ignored until tiny white spots were noticed in sections of the insulation. A more careful examination produced the hypothesis of 'water trees' as being responsible for the failure. Under the influence of the electrical stress, water gets into the insulation and accumulates near impurities. The formation of a microscopic string of water droplets is the first step in a new process of electrical breakdown.

The projected future of electrical power transmission in North America opens new areas of research for Dr Densley as well. The economics of power transmission indicate that cables will operate at extremely low temperatures using superconducting or cryoresistive conductors. These cables are capable of carrying exceptionally high power since the conductors exhibit little or virtually no electrical resistance.

Such cables, which are at present in their developmental infancy, represent novel research problems since they must incorporate insulations capable of functioning for many years at temperatures more than 200°C below freezing point. Dr Densley's laboratory is now being geared for research in this new region of extremely low temperatures. ②

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Unusual maintenance problems for Telecom at

Australia's highest telephone exchange

The operation and maintenance of Australia's highest telephone exchange—on the top of the 1861 metre high Mount Hotham in the Victorian snowfields—poses some very unusual problems. Iced up bimotional switches, percolating powder snow, howling blizzards, sub-zero operating temperatures, and power generation difficulties have provided far more than the usual problems encountered by country technicians.

by W. DUNSTONE, STO BRIGHT and P. RANGLES

Hotham Heights was served in the early period of Victorian Alpine Skiing by a Single Wire Earth Return telephone line from Harrietville at the foot of Mount Hotham. This was a time when lines staff and technicians talked about "going in" to the area by horseback and skiing. The almost derelict shelters now seen along the way were an inviting comfort and

many times technicians and engineers used these shelters overnight, relying on tinned food left behind by previous visitors.

In the late "50s", when skiing initiated a period of fairly rapid development, which is still continuing, the SWER line was abandoned and a single channel radio system was installed in party line

connection with the nearby resort chalet at Mount Buffalo. At the Hotham end the radio apparatus was installed in the cellar of the Mount Hotham Heights hotel, which was recently destroyed by fire. The telephone service was operated by the hotel licensee for two half hour periods each day. A magneto pyramid switchboard serviced the half dozen subscribers.

In 1971, when skiing was being classified as a boom sport in Australia, the then PMG Department decided that a more modern service would be appropriate for Mount Hotham and the existing network was converted to automatic working using a "C" Type RAX (Rural Automatic Exchange) with a modern 12 channel radio link to German Creek (near Bright) and then via trunk cable to the Wangaratta ARM. Full STD facilities were available and with the provision of these telephone facilities, the PMG Department must be given credit for accelerating the development of the resort.

Water from power points

However, various problems were found with the installation of the telephone exchange at the top of the mountain. Freezing conditions below minus 6°C prevailed constantly and the water vapour within the building condensed to form thin films of ice which were sufficient to bind the bimotional switches within the exchange.

Obviously, heating of the equipment within the building was required. However, at the time it was not known just how critical conditions would be for this exchange and its supporting equipment. Soon after installation it was obvious. Any small opening on the outside of the building, eg., nail holes in the roof particularly, had to be sealed. Fine driving snow is like fine dust; it finds every opening. Snow, however, unlike dust, melts when it is warmed and of course the snow that entered the roof was soon melted and dripped down the walls. It was not uncommon to see small



STTO Wally Dunstone (front) and Technician Max Newton on the Ski-doo.

streams of water issuing from the AC power outlets in the walls!

Power vs the elements

Because there was no commercial electric power reticulation we had to generate our own. This was provided by a single 6kVA diesel alternator. Unfortunately, this machine was not able to keep up with the demand made on it and it frequently gave trouble. It was housed in a ski tows shed and subject to much abuse from the cold, streams of water flowing around it and anxious technicians and mechanics attempting to operate it, usually late on Friday nights when most people were warm in bed.

In the summer months the exchange power was obtained from a wind generator. A special protective coating of teflon was sprayed onto the blades of the generator to prevent snow sticking to them so that the generator would remain operational in fairly heavy snow conditions. It was not realised that snow would build out from the hand rail at the top of the tower to the extent it did and in due course the blades came in contact with the snow build-up and were immediately buckled.

Blades not found

It also became clear that the generator should not be used during the winter period. A new set of blades was installed the next summer and the generator worked well, until a particularly heavy wind gust caught the blades, wrenched them off the main axle, and sent them spinning into the sky. They have not been found.

Because of the difficult conditions the radio system used to drift off frequency at 0°C and thus isolate the exchange!

The lines staff have also had their problems. One thousand metres of dual 100mm galvanised iron pipes had to be laid to provide adequate earthing and a good shield against lightning. The trench



Field staff go by Snow-cat to the Mt. Hotham exchange. Note the build up of ice on the upper sections of the mast's structure.

re-instatement had to be performed according to strict regulations set down by the Soil Conservation Authority of Victoria with various grasses sown. Nature allows only about one per cent regrowth per year at these altitudes, so permanent damage could have been done to the mountainside if not for these conservation measures.

By 1976 the "C" type RAX had been replaced with the latest ARK M, the single diesel replaced by two diesel alternators (one running continuously), housed in the basement of the public amenities building, and accommodation facilities for staff placed alongside the exchange. All of the equipment now operates in "warm" conditions (about 8 to 10°C) and provides a reliable service to the Mount Hotham subscribers.

Toyota land cruisers are used for transport to the area. Located in the area are a Snow-cat (a Volkswagen powered snow transporter) capable of carrying seven persons plus heavy test equip-

ment, and a Ski-doo for rapid transit around the Hotham village. This can carry two people, manuals, telephone instruments and small test gear.

Special mention should be given to the Lands Department, the Committee of Management and the local mountain dwellers without whose help the installation and maintenance of the Hotham Heights exchange would be very hard.

Present services

Present services provided by the exchange include full STD facilities, telex facilities for two subscribers, four single channel radio subscriber systems, an emergency telephone service for the Diamantina hut, lighting for the public amenities building, and a remote 50V power feed for a mobile radio base station.

Reprinted from "Telegen", published by the Engineering Department, Telecom Australia.

The shadow-mask colour picture tube

... the story of its early development

This article is an eyewitness account of the early experiments leading to the development of the shadow-mask colour picture tube. It discusses the importance of the new colour display to the two systems then under development—RCA's, which was compatible with b & w receivers; and CBS's field sequential system which was incompatible—and describes the all-out crash program at RCA that was to result in the adoption of the compatible system in 1953.

by DR H. B. LAW

Toward the end of September, 1949, at RCA Laboratories, Princeton, New Jersey, selected members of the technical staff were asked to attend a special meeting. No reason for the meeting was given. However, one of the main topics of interest at the Laboratories was RCA's ongoing objective to devise a system for broadcasting television pictures in colour without obsoleting the million or more black-and-white receivers then in use. I suspected the meeting might be concerned with this subject. My suspicion was well founded.

Black-and-white television, by 1949, was well advanced and receiver sales in the United States were expanding rapidly. In various research laboratories, notably CBS and RCA, work on colour television was active. However, the circuit engineers were handicapped because there was no colour counterpart of the black-and-white cathode-ray tube.

At CBS, a field-sequential colour system had been developed in which a mechanically rotating colour disc was placed in front of a black-and-white picture tube to display pictures in colour. The pictures were excellent, but the system was incompatible with the black-and-white system, and the picture size was very limited.

At RCA, a simultaneous system had been developed which used three side-by-side broadcast channels, one of which was compatible with black-and-white. However, the increased number of channels could be made available only at a frequency region just beginning to be explored for broadcast purposes. The

greatest disadvantage for the RCA group, however, was the lack of a satisfactory display for colour comparable in size and performance to the picture tube used for black-and-white.

I had joined RCA in 1941 at Camden, New Jersey (N.J.), where I worked under the television pioneer, Dr V. K. Zworykin, on more sensitive camera tubes. In 1942 we were moved to the new RCA Laboratories facility at Princeton. There Dr Paul Weimer and I joined Dr Albert Rose, who had been at RCA, Harrison, N.J. The three of us began work under Dr Zworykin to develop the image-orthicon camera tube, an idea originally advanced by Dr Rose. Our work during the World War II years was directed to military applications, and we were quite successful in our efforts to increase camera-tube sensitivity by means of this new device.

At the war's end, although I continued on camera tube work, I became interested in the colour television work of some of my colleagues at RCA, particularly the need for a cathode-ray display that could be used for colour. I watched with interest as Dr Frederick Nicoll tried to make a colour screen by settling colour phosphors through a wire grill onto a flat glass plate. By settling phosphor three times with different colour phosphors and shifting the grill, a screen was produced with the phosphor stripes nested together. Neither Ted Nicoll nor I knew how to use the screen in a practical way to display colour pictures, but it seemed like a step forward to be able to make the phosphor-line structure.

Another inventive colleague, A. C.

Schroeder, was devising possible colour-tube structures, although he was primarily a circuit engineer. Al actually built a projection tube with three electron guns in three necks where the necks blended into one neck, which made possible a single-deflection yoke. The beams produced three small adjacent black-and-white pictures on the tube face. Red, green, and blue filters, mirrors, and a lens were used to project and superimpose the pictures on a screen, but the resulting colour picture was extremely dim.

Now back to that September, 1949 meeting. We were told that colour television was at a critical stage. The Federal Communication Commission had called a series of hearings earlier in 1949 to discover whether or not it was possible to standardize on a colour system within the 6MHz channel then in use for black-and-white. The CBS group advocated their incompatible field sequential system, which they demonstrated by using a rotating filter-disc display.

RCA had devised a subcarrier colour system which was compatible; that is, it produced good black-and-white pictures on existing receivers, and colour pictures on experimental colour receivers designed to demodulate the subcarrier. Unfortunately existing projection-tube displays, and a very complex direct-view display containing three orthogonal picture tubes whose pictures were combined by mirrors, lacked convincing evidence of practicality. It appeared that, unless a direct-view colour picture tube was developed, the CBS colour system would have to be used, and it would compete with black-and-white, rather than complement it.

It became clear at the September meeting that those invited were about to be challenged to show feasibility of a direct-view colour tube and to produce results in double-quick time. We were told that RCA had decided to embark on an all-out, no-holds-barred effort to develop a colour-picture tube. Feasibility was to be shown in three months. There was to be no limit to expense, and any

manpower that could contribute, anywhere in the company, would be made available. The task of coordinating and organizing the activity was assigned to Dr Edward W. Herold.

Staff members in research had great freedom to work on their own ideas, and we found it very stimulating to talk to others about their ideas and problems. Because of my interest in colour display work, I had undertaken a few experiments of my own, dating from 1946. In mid-1946 I learned of a Schroeder idea, which prompted me to record the following in my notebook:

"It seems on thinking the matter over that Schroeder's idea for a three-colour kinescope deserves a try. The idea referred to is one in which three guns scan a grille that serves to mask lines of different colour phosphors from certain of the beams."

I then made several attempts to construct a screen. The first attempt produced a fine particle cloud over a pinhole in a chamber that was continuously evacuated. I had hoped that particles would be accelerated through the pinhole and fly in straight lines to a grill and that those going between the wires would form lines of particles. However, the lines produced were not nearly sharp enough to be useful.

Next I tried evaporating boron oxide through a grill to the glass and then dusting phosphor over the glass surface, hoping that when heated the phosphor would adhere to the boron oxide made tacky by the heat. Other materials were also tried but sufficient adherence could not be obtained. Settling the phosphor first and then evaporating the binder through the grill also was tried but did not show promise.

After several months, I returned to the problem but this time applied a layer of Hanovia rose-red luster stain on the glass and then a layer of cold top engraver's enamel, a shellac-type photosensitive resist sometimes used when making halftone printing plates. An exposure with uv light was made through a wire grill. Upon development with alcohol, the alcohol undercut the resist lines and lifted the entire pattern. An attempt was made to mix the cold top enamel and stain so that the combination could be coated and exposed. The two materials were incompatible and formed a useless mess.

A year or so later I returned to boron oxide and found that a much thicker layer, when made tacky by heat would retain phosphor, but definition tended to be lost by spreading of the boron oxide with heating when satisfactory adherence was achieved.

Another year elapsed before I tried again, this time by settling a screen through a grill, somewhat as I had seen Nicoll try. A sharp line pattern was obtained, but with defects. It was then (1948) that I made the following entry in my notebook:

"It would be highly, advantageous if the phosphor strips could be applied by a photographic process since it would be

easy to get a good mask by ruling and etching glass and filling the grooves with opaque material. Such a process would accommodate itself to a curved faceplate.

"It may be possible to do the job by settling the phosphor in a photosensitive solution of gelatin, potassium dichromate, and silicate binder. When the solution is poured off it would be light-sensitive. Exposure would harden the gelatin and trap the phosphor while the unexposed portion would rinse away. The silicate binder might have to be omitted.

"Subsequent firing in the air would remove the gelatin and leave the phosphor. The second set of strips could then be applied."

I was not to become aware of the importance of this entry until some years later when it became the basis of phosphor deposition now used in all colour-picture tubes.

It was early 1949 before I again returned to colour-tube experiments. Working with a demountable vacuum system, I turned to a different structure consisting of thin metal vanes mounted perpendicular to the faceplate with phosphor on the sides of the vanes and on the faceplate between the vanes. With alternate vanes electrically tied together, the electron beam could be made to strike the sides of one set of vanes or the other set, or go through to the glass for the third colour, depending on the voltage applied. The voltage required between the sets of vanes to obtain a single colour was excessive, so I started to design a three-gun system that avoided high-voltage switching to change colour. Slot apertures between the vanes permitted each beam to see only one colour in an application of the shadowing principle.

In a separate experiment related to this vane-structure idea, I built three guns in a delta formation and put them into a 12-inch tube with a 2-inch neck and a

white screen so that I could examine the problem of keeping the spots together during deflection. The angle between the guns and the tube axis was about 2°, and each gun was independently mounted on a rod in a small glass tube so the spots could initially be brought into coincidence at the center of the screen by carefully warming up the glass to repoint the gun before removing the tube from the pump.

This experimental tube was not quite complete when the opportunity came to go all out on the "crash program" to build a colour tube. After the meeting, my mind again went back to the shadow-mask idea, but this time to a different form of the Schroeder design in which the mask contained a hexagonal array of holes instead of a wire grill. The problem was to locate precisely the positions, beyond the apertures, where the electrons were going to strike, and to then place phosphor dots at exactly these locations in a practical and straightforward manner.

All at once the thought occurred to me that, after deflection, the electrons travel in field-free space so their paths are straight and can be simulated by light. Therefore, a light-sensitive material, such as a photographic plate, temporarily positioned in the same location as the faceplate, could record the phosphor-dot positions for a given colour if a point light source were placed at the deflection centre of the beam for that colour.

If a photographic plate were used, one could then print a photoresist pattern on thin metal foil such that the black spots or phosphor-dot locations would not be exposed and would develop out free of resist. Holes could then be etched through the foil where the phosphor dots should be, so the foil could be used as a settling mask. All that would be

Harold B. Law, Staff Adviser, Materials Research Laboratory, RCA Laboratories, Princeton, N.J. received the BS in liberal arts and the BS in education in 1934 from Kent State University. He received the MS and PhD in physics from Ohio State in 1936 and 1941. Dr. Law joined RCA, Camden, in 1941 and in 1942 transferred to RCA Laboratories. He became a Fellow of the Technical Staff in 1960 and from 1962 to 1975 was Director of the Materials and Display Device Laboratory, a laboratory affiliated with the Electronic Components and Devices Division. Upon joining RCA, Dr. Law first worked on television camera tubes and then on colour television display tubes. He is a Fellow of the Institute of Electrical and Electronic Engineers, a Fellow of the Society for Information Display, and a member of the American Physical Society and Sigma Xi. For their development of the image-orthicon television camera tube, Dr. Law and two of his colleagues received an award from the Television Broadcasters' Association in 1946. In 1955 he received the IEEE Zworykin Television Prize, in 1966 the Consumer Electronics Outstanding Contribution Award of the National Electronics Conference, and in 1975 the Frances Rice Darne Memorial Award from the Society for Information Display and the IEEE Lamme Medal. He is co-author of the book *Colour Television Picture Tubes*, published by Academic Press, has been issued 40 U.S. patents, and has published 11 technical papers.



required in addition was to provide some way to locate the settling mask in the proper position on the faceplate. For this purpose, alignment holes in the mask frame could be used to record alignment marks on the photographic plate at the time of exposure.

All of the above procedures seemed to be relatively easy to carry out with a high probability of success. However, there was one experiment I decided to do before getting too excited. I prevailed on Paul Weimer to let me use his demountable vacuum system to scan an electron beam over a wire mesh placed about 1/2 in. in front of an aluminized phosphor screen. With a microscope I observed that the shadows cast by the mesh were very sharp and clean, so the beam could certainly be shielded from striking phosphors of a different emission colour lying extremely close by. It was then that I felt confident that I would be able to build and demonstrate the basic Schroeder-tube design.

The mask-screen structure was repeated for a sealed-off version and after a couple of tries a tube was produced in which red, green, and blue colour fields could be produced and the grids could be modulated with video. At this point, about six weeks after the September meeting, the tube was turned over to L. E. Flory and his associates, who had been assigned the circuit program for operating the tube. They used small permanent magnets to achieve coincidence of the undeflected spots in the centre of the screen and were able to show three-colour pictures for the first time on a Schroeder-type tube.

I recall Les Flory being so pleased with the result that he declared "we would be making colour pictures the same way five years from now." It sounded like a rash statement then, but actually after more than 25 years the shadow-mask tube is still the only one in use. Moreover, light exposure in a piece of equipment called a lighthouse is still used today in practicing the same basic procedure for locating the phosphor-dot positions.

I immediately began to design the tube geometry and to think about construction details. Since I had no thin metal with a hexagonal array of apertures for a mask, I decided to make the mask by etching. First, though, I needed the proper photographic pattern of dots, so I wound a wire grill on a frame of threaded rods and with the help of Tom Cook, our laboratory photographer, made a double-contact print, the second exposure after rotating the grill 60°. A hexagonal array of diamond-shaped elements was produced, but Tom was able, by printing with an overexposure, to round off the sharp corners to produce a usable pattern. With this pattern I made the first thin metal masks.

In preparation for making the phosphor screen, the next step was to make exposures through the mask from three points located according to design

with respect to the mask assembly. It was desirable, also, to somehow keep track of the physical location of these exposure points, or colour centres, so the mask-screen assembly could be mounted in the proper position in the tube; that is, mounted in such a position that the colour centres would coincide with the centre of deflection of the yoke when the yoke was placed in its normal position on the tube neck. In addition, it was necessary to have a means to determine the correct orientation of the three-gun cluster at the time it was being sealed in the tube neck.

For this experiment the problem was solved by building a superstructure or "lighthouse," which was attached to the mask-frame assembly and carried a small metal plate with three exposure apertures. After three exposures were made on three pieces of photographic film, the remaining steps were carried out according to plan. Finally the lighthouse was removed after the mask-screen structure had been put in place in the tube.

Three individual electron guns were sealed into the tube neck on tungsten rods, as described in the earlier experiment, and the tube was placed on a vacuum system to pump. Two guns gave enough emission to test but the third was inoperable. Nevertheless, it was a thrill to see the screen change from one colour to another by simple adjustment of the grid biases. The experiment was considered a big success and resulted in a number of people at the Laboratories dropping in for a demonstration.

Of course, the inauguration of the RCA crash program led to many other projects within the company. One team, headed by a colleague, Dr Russell Law, devised a one-gun version of the shadow-mask tube using masks and screens that I supplied for the first tubes.

The status of the projects at RCA Laboratories as of two months after the September meeting are contained in notes made by Ed Herold at the time. He wrote, in part, as follows:

"One of the demonstrations showed a colour picture on a single tube reproducer using 150 sets of three-colour phosphor lines and a single electron gun ... A 150-line, non-interlaced, scanning raster was used, accurately aligned with the ruled phosphor line sets. The picture was approximately 4 1/2" by 6" ... and was quite excellent and showed about 300 lines horizontal resolution and good colour fidelity ...

"A second demonstration showed ... a single-gun tube using the shadow-mask direction screen (see below). This tube was demonstrated with a television black-and-white broadcast picture, which could be shown in any one of three colours by rotating a yoke around the neck of the tube.

"A three-gun tube was demonstrated that employed a shadow-mask screen aligned with tri-colour phosphor dots. This tube produced a colour picture approximately 4" by 5" with a good rendition of colours and adequate brightness. The colour pic-

ture appeared to be well registered and converged at the centre of the picture, and fair registry was obtained out to the edges. Either simultaneous or dot-multiplexed signals could be employed. Because of the small number of dots employed, resolution was not high but the future possibilities of this method seemed clearly demonstrated."

The results described, after only two months of intensive work, were so encouraging that doubts and gloomy forecasts were forgotten.

I decided to make the shadow-mask tube with a larger screen size and found that the mask had to be stretched tightly over a frame to obtain geometric stability. The settling masks were more difficult to make and use, and the assembly techniques were very crude for the accuracy needed. However, Ed Herold and many others were convinced of the promise of the shadow-mask tube and the lighthouse technology for making it. My own efforts were soon swamped by an avalanche of others helping in many ways to make a tube with a 12-inch diagonal picture size.

Dr Jan Rajchman took the lead in enlisting the Buckbee Mears Co. to furnish masks to our specifications with very gratifying results. Norm Freedman and Ken McLaughlin were soon supplying phosphor screens for tubes made by silk-screening instead of settling; they used the lighthouse exposure of a Kodolith glass plate to obtain the pattern for their silk screen.

Nan Moody and Dave Van Ormer at Lancaster went to work on the gun cluster and came through with assemblies that worked very well. The three guns gave beams that emerged parallel into an

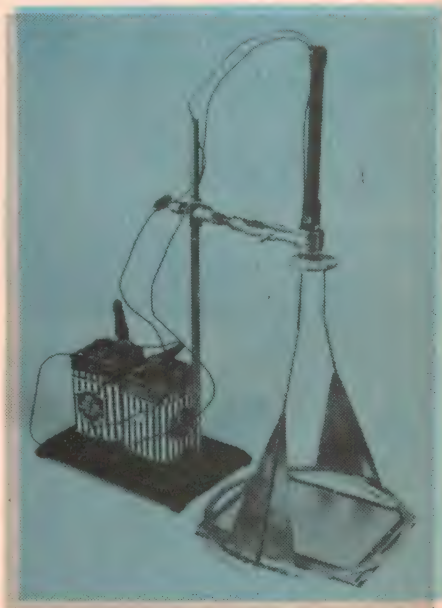


Fig. 1: Lighthouse used in printing the first experimental shadow-mask colour tube. A photosensitive film is located in the phosphor-screen plane. It is exposed from a point source in the lighthouse and through the shadow mask to locate the desired phosphor dot positions.



Fig. 2: This experimental shadow-mask tube was the first of its type to display colour pictures. It was developed by the author towards the end of 1949.

electrostatic converging lens. Al Friend found ways to visualize the problems of keeping the three beams together at the screen during deflection, and was able to make modifications in the magnetic yoke windings as well as control especially troublesome areas by the insertion of magnetic tabs.

B. E. Barnes and Dick Faulkner were faced with the task of making a bulb that could be opened near the faceplate and provide assembly tolerances for the mask-screen and triad of guns that was far beyond anything that had been attempted in such a large structure. In fact, the most frightening aspect of the whole tube was soon appreciated as being the extremely tight tolerances that needed to be held in essentially all phases of manufacturing the tube, including particularly the mask-screen assembly where some errors could not be compensated for by means external to the tube.

At the FCC the showdown was still ahead over which colour system would be approved by virtue of the type of standards to be adopted, so that efforts were redoubled to produce the best tubes possible for the upcoming demonstration. At Harrison, box after box of Kodalith plates were used in fabricating mask-screen "Telechrome" units that were sent to Lancaster for tube finishing. The finished tubes were transported to Princeton for appraisal and feedback.

Early in February, 1950, another internal company demonstration was held, which was described in Ed Herold's notes as follows:

"A large group of visitors from Lancaster, and from Harrison, were shown a series of demonstrations on Saturday, February 11, 1950 at RCA Laboratories, Princeton . . . By the time of this demonstration, 16" metal envelopes had been employed for some of the types and a silk-screening technique had been worked out for making line-

screen tubes and shadow-mask dot-screen tubes . . .

"A 9" by 12" picture using the shadow-mask direction screen and a single electron gun operated from a standard RCA dot multiplex signal was demonstrated and shown to have good colour fidelity with fair picture brightness. A three-gun form of shadow-mask tube was also demonstrated and showed a picture that was also considered to be generally excellent at the time."

Continuing, we learn of further developments:

"Work was started on a receiver for the three-gun type of shadow-mask tube and a second receiver for the one-gun type. In each case, a standard 16" black-and-white receiver was used and the additional tubes and circuits added for the colour kinescope so as to convert the receivers. In the case of the three-gun type, it was decided to use a cathode-sampling circuit and every effort was made to use a sufficient number of tubes and components to permit a high picture reproduction. Separate high-voltage supplies were used, capable of delivering about 13kV for the early test. The finished receiver used 19 additional tubes over those originally in the black-and-white receiver.

"The receiver for the single-gun shadow-mask colour tube, on the other hand, was designed so as to introduce the fewest number of tubes and the simplest of components. It was found possible to make this receiver with only 10 additional tubes over the black-and-white chassis . . ."

One succinct trade-press comment comes from the Television Digest after a March 29, 1950, demonstration to the press:

"Tri-colour tube has what it takes: RCA shot the works with its tri-colour tube demonstrations this week, got full reaction it was looking for—not only from more FCC members and several score newsmen, but from 50 patent licensees who came to see for themselves.

"...many seemed ready to go all the way with RCA now that they've seen normal-

looking, compact receivers (no "grand pianos") giving decent pictures.

"Adoption of either CBS or CTI, by themselves, can now be ruled out unequivocally. Their only chances, particularly those of CBS, lie in multiple standards permitting virtually any 6-Mc system . . ."

Multiple standards it was, for on September 1, 1950, the FCC issued its first report on the hearings, stating that the CBS system was the only one ready for standards. I proposed that the industry adopt "bracket" standards to permit either CBS or standard transmissions for all receivers made in the future. RCA held that bracket standards were impractical and petitioned the FCC to withhold a decision until June 30, 1951, pending further comparative tests. The FCC denied the petition and issued orders setting the standards for the CBS system, with commercial operation to begin November 20. RCA filed suit in the US District Court to set aside the FCC order. The Court issued a restraining order preventing start of commercial colour on the CBS system until the Court had time to review the decision.

In the period that followed, RCA gave extensive demonstrations in Washington to industry, government, and the press. Receivers were shown with improved colour tubes having 585,000 phosphor dots, new red and blue phosphors, and resolution and brightness (25 ft-L) about equal to black-and-white. Nevertheless, on May 28, 1951, the US Supreme Court affirmed the FCC ruling in favour of the CBS system and authorized the start of colour TV broadcasting on June 25.

Broadcasting on the CBS system standards never got under way because on November 20, 1951, the National Production Authority Order M-90 prohibited all manufacture of colour TV components and receivers due to the war effort. The effect of this action was to give more time for sober thought on a compatible system. Indicating broad support of industry for such a system, the National Television Systems Committee held a meeting on June 18, 1952, to consider the subject of compatible colour TV. After extensive deliberation the committee recommended a system of compatible colour TV that was similar to but improved over that proposed by RCA. Approval was granted for the NTSC system by the FCC on December 17, 1953.

Although colour broadcasting standards remained in doubt for a long period of time, there was no doubt about the utility of the shadow-mask tube, because it was suitable for either the CBS or RCA system. The major problem was how to mass produce the tube at a reasonable cost. Having to process a photographic plate and make a silk screen for each tube was expensive. The solution seemed to be traditional mass-production techniques making use of interchangeable parts. This would imply that the mask, first of all, should be made interchangeable so that interchangeable screens could be used.



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See E.A. May 77 for project details.

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Enclosure kits, with instructions, Cat C-2622 \$124.00

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PER PAIR

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\$189²⁵

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Looking ahead to this eventuality, RCA invested in a large three-colour Vandercook printing press at Lancaster and undertook a research program with Lehigh University's National Printing Ink Research Institute. The program objective was to develop ink formulations for printing the relatively coarse phosphors on the flat glass screen plate that would then be mounted inside the colour tube.

Progress was being made toward interchangeable masks, but it was accompanied by an enhanced appreciation of the geometric distortions that can be produced when the mask is mounted on a frame under highly stressed conditions.

Another nagging problem that increased cost was the slow heat cycling required in processing the tube because

of the internal flat-glass screen plate. It heated and cooled mostly by radiation and was in danger of cracking if the cycling was too rapid.

In the midst of the struggle for mass production at RCA, a new technical development was announced at CBS-Hytron and later published. Instead of using a flat mask and an internal screen plate, the mask was spherically curved and mounted close to the similarly curved faceplate of the tube. Phosphor was applied by means of the lighthouse to expose directly a photosensitive binder containing the phosphor on the inside of the faceplate. The exposed portion remained and the unexposed portion could be washed off. A repeat of the process made it possible to print successfully all three primary colour phosphors.

Within a short time RCA, Lancaster, put

together a curved-mask tube using photosensitive binder for phosphor deposition and confirmed the considerable advantages inherent in the system. One of the most obvious advantages to the viewer is the display of the picture on the tube face as in black-and-white picture tubes rather than on an internal screen. RCA adopted the system, which essentially opened a new era in the practical manufacture of the shadow-mask colour tube and marked the end of the early development period.

It is hard to believe that those first few experiments could have led to a device that reached a cumulative production of over 100 million units worldwide. It should now be abundantly clear, however, that although I performed the experiments, the basic design of the colour system and tube was already there.

Appendix

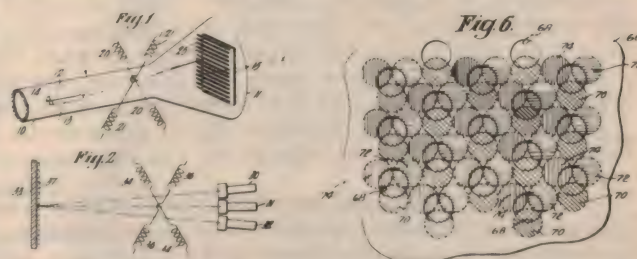
As indicated in the text, the author chose the shadow-mask colour tube idea described to him by A. C. Schroeder, and later patented by Schroeder, as the beginning point in a crash program to develop a single display tube for colour television. Selected drawings from his patent are reproduced and the concepts in the patent made use of are given below as a matter of interest. However, unknown to Schroeder

or the author until much later, a patent was applied for on July 11, 1938, by Werner Flechsig in Germany that appears to be the origin of several basic ideas along the same line. One year later the Flechsig application was filed in France and a French patent was issued on March 31, 1941. The drawings of this patent are also reproduced and a summary of the concepts disclosed are summarized below.

A. C. Schroeder, Patent No. 2,595,548; filed February 24, 1947, issued May 6, 1952.

The first two patent drawings show three closely spaced beams that are deflected by a single deflection yoke with the beams coincident at the screen and penetrating a shadowing structure or mask.

The third drawing shows that when the mask has circular apertures arranged in a hexagonal pattern (solid circles), a nested array of phosphor dots can be formed back of the apertures. The array really consists of three interlaced arrays of different colour-emitting dots. When used with a properly oriented delta gun cluster having correct dimensions, each beam will strike dots of only one colour.



Selected figures showing three beams deflected by a single deflection yoke and the relative arrangement of mask apertures and phosphor dots.

Werner Flechsig, French Patent No. 866,065; filed July 11, 1939, issued March 31, 1941.

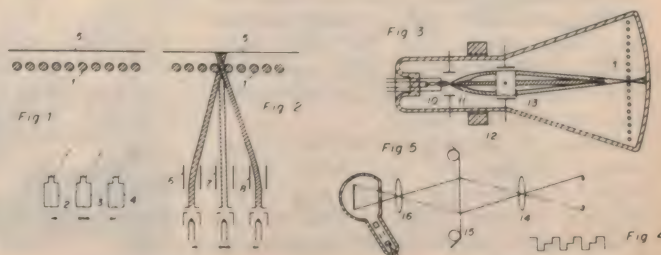
Fig. 2 of the Flechsig drawings shows shadowing by a grill to obtain colour selection at the screen. Fig. 1 indicates how the screen may be formed by evaporating luminescent material or colour filter material through the grill from sources placed at the centre of deflection of the beams. In Fig. 3 one beam is successively deflected to the three positions occupied by the beams in a three-beam embodiment and direct to a common point at the screen. A staircase switching voltage, which would accomplish this operation, is shown in Fig. 4. In Fig. 5 the same principles are applied to a camera tube.

The following concepts are contained in the Flechsig patent:

- 1) A shadowing structure that consists of a wire grill is used to permit excitations of a selected colour at the phosphor screen.
- 2) Three electron beams converge at the grill and strike separate areas on a phosphor screen beyond the grill as a consequence of the grill's shadowing action.
- 3) The three beams are deflected with either individual or common deflection means from the same position along their respective paths.
- 4) The screen consists of phosphor lines, or colour filter lines, prepared by causing the appropriate material to emanate as by evaporation from the points from which the beams are deflected. The material being evaporated at the screen is subject to the same shadowing action by the grill as are the electron beams.

5) The grill openings become cylindrical lenses for concentrating the electrons into narrow lines at the screen if the potential of the screen is made positive with respect to the grill.

6) If the electrons are sufficiently concentrated by cylindrical-lens action at the grill, the grill wires may be made very small in diameter and still perform their shadowing action. To deposit the screen the wires must then be temporarily enlarged, as by coating, to prevent the phosphor lines from being too wide and overlapping. The coating can be removed after the screen is made for normal operation of the tube.



Figures from Flechsig patent show shadow mask colour tube principles in a grille-type tube.



Forum

Conducted by Neville Williams

More about TV servicing charges

In the April issue, in both "Serviceman" and "Forum", we discussed the problem of servicing charges and suggested a basis on which they might be arrived at. While we were prepared for criticism on the grounds that we were encouraging "rip-off merchants", in fact, the only correspondence and comment we have had has been in appreciative terms.

To say the least, this has been a pleasant change from some of the correspondence that has been addressed to (and through) newspapers and magazines during the past few months, on the subject of CB radio. With the contending parties so strongly polarised, it has been impossible to avoid upsetting some people, whatever views one expressed, or even if one simply sits on the fence!

But, getting back to servicemen, the reaction has been one of interest in what was a genuine attempt to document the basis on which charges can logically be made.

As we have envisaged, the article proved to be of interest to other than servicemen, having an obvious relevance to self-employed tradesmen of almost any ilk. But we must confess to being taken aback by discovering the issue on the table of a prominent executive from the medical field who saw in the methodology something more systematic and demonstrable than the methods currently used to set doctors' fees.

So to the first letter:

Dear Sir:

Congratulations on the "Serviceman" and "Forum" articles in the April, '77 issue. It is the first time I have ever seen articles along these lines in "Electronics Australia".

They should help a lot of people. The serviceman will have a sounder basis for costing, and will be able to quote reasons for a base service rate. The public may start to realise the real cost of operating even a one-man business and they may see it as less of a 'rip-off'.

When TV commenced 20 years ago, service charges per hour were about 1/8th of an average week's pay. If the average income today is \$180.00 per week service should be \$22.50 per hour to be on a parity.

I have enclosed a duplicated copy of

a costing outline, which I completed 2 days prior to receiving the April E.A. for the Association of Christian Technicians (T.A.C.T.). It was intended as a basis for discussion. While the means of deduction is slightly different, the end result is almost identical.

N.J.B. (Keiraville NSW)

The summary mentioned by N.J.B. is not suitable for reproduction having been devised, as he said, to serve mainly as a basis for group discussion.

However, he does come up with an average figure of \$9.70 per hour which a self-employed serviceman must recover if he is to enjoy salary and conditions commensurate with what he could expect as a technician in industry. But that figure assumes a 100% effectiveness—he would be doing directly saleable work for all of the 44 hours he was supposed to be on duty.



What do you mean... twelve dollars... just to knock on my door?

In fact, he has to answer the telephone, spend time on the road, talk to customers have an occasional cup of tea, attend to bookwork, etc so that, in practice, effective production efficiency for a small business is likely to fall to about 50%. As a guide, 75% efficiency pushes the job per hour rate from \$9.70 to \$14.85; at 50% efficiency, the figure climbs to \$19.40.

He adds the following interesting observation: "In industry, a quick calculation is commonly made for job costing based on wages multiplied by 2.4. Thus, for a wage level of \$200 per week, the job cost is \$480 per week or \$96 per day."

Appended to the discussion material is a set of figures which were taken out for the year 1975-6, covering the actual cost of a home-operated one-man service business. Without allowing anything for rent of premises or for bad debts, the figure came out at \$9477. Add \$200 per week for wages and the required input must be \$19,877. Allow for holidays, assume a job efficiency of 50% and the rate per productive hour comes out, once again, at around \$20.

The figure emerges with monotonous regularity!

NJB also has some observations to make about the hiring of public address and similar equipment—a subject which was mentioned briefly in the April issue. The figures he chooses may suggest some lack of sagacity on the part of the investor but they do indicate how a serviceman could get caught.

Under the heading "The Staggering Cost of Ownership of Equipment", he assumes that a serviceman may have sought to diversify by investing in P.A. equipment—worth say \$1000, all up.

Loss of interest on the \$1000 thus tied up will cost about 10% or \$100 per annum. After about seven years, the equipment will have very little residual value, which means that it has to be written down by about 15% or \$150 p.a. Cash to this same figure will need to be earmarked to replace the equipment, amounting to another \$150 p.a.—a figure that allows nothing for escalating prices. Insurance, routine maintenance and restoration of damage may typically add a similar amount, representing a potential liability of \$550 per annum. So, if the equipment was hired out once per month at a cost of 4% of capital outlay (\$40) the serviceman would not even recover his real cost, let alone be recompensed for the time involved attending to hiring (including the paperwork), checking and storing the equipment after return, and carrying out any maintenance.

Very obviously, a serviceman who intends to become involved in this kind of activity needs to do another complete set of sums. He must also consider whether he can afford to "be a good fellow" and lend the equipment at a cut rate or gratis to the very organisations

which would logically be his paying customers!

Another letter which I would like to quote comes from a reader in Hornsby, NSW, who feels that the hourly rate concept should not be regarded as an end in itself. It should merely be a step towards a method of more acceptable charging from the customer's point of view:

Dear Sir,

I found the article "How much you should charge?" very interesting but I found cause for disagreement, not in its substance (the hourly charge you arrived at would seem to be fair enough) but in its suggestion that charges should be made by the hour.

I know that this may be a valid method at arriving at costs but as a method of imposing charges it leaves a lot to be desired. A customer would far prefer to be given a definite quote before the job is done and from the serviceman's point of view, it makes the customer much less inclined to argue over the bill when it is presented. And the serviceman is thus subject to less psychological pressure to charge uneconomical rates!

Such quotes are not hard to arrive at; first of all the serviceman makes a base charge for the call, an absolute minimum would be about twelve dollars. If the set obviously requires nothing more than a few setting up adjustments that take a maximum of about fifteen minutes, an extra charge of say three dollars could be made, making a total charge of fifteen dollars.

But if a component failure is indicated or convergence is seriously out of plumb (indicating component failure or fiddling), then the set should be taken back to the shop. This necessitates two calls, twenty four dollars plus time on the bench (say ten dollars) making a total charge of thirty four dollars.

By the time the one man service organisation makes a call, brings the set back to the shop, fixes it up and then returns it to the customer, it is not likely that it will be able to handle much more than two sets a day making a week's return of three hundred and forty dollars. Cost of components would have to be added to the rates but the customers will not ordinarily be inclined to argue about something as concrete as the cost of a component.

The point is that fixed charges put a definite quality to the costing procedure. Taking the set back to the shop when a component fault is indicated as an established procedure might go against the grain for some servicemen who try to do as much of the service in the home but it is an essential part of the system. It saves the possibility of wasting time in the home looking for a fault that in the end has to be fixed back in the shop and it saves the possibility of the customer quarrelling with the charge when the fault takes only a few minutes to locate and fix. (Such faults can be easily out-



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FORUM—continued

weighed by those that take hours and hours to locate and fix.)

Charging for time penalises the elements of skill, experience and luck that a serviceman brings to each job and rewards their opposite and the essential unfairness of this puts the serviceman at a psychological disadvantage.

There are other reasons for not doing the actual job in the home. Customers tend to be housewives, intensely conscious that, in their house, they are the boss. It tends to breach customer relations if you turn their living rooms into workshops.

Also, it is very desirable for the sake of preventing call-backs, if after making a repair, you can give the set a soak test.

You may object that I am ignoring modular construction and that, in the first instance, repairs to most modern sets can be effected by merely changing a board. This is so but it is something which is of most advantage to one brand rental houses and would be of little help to the one man service shop that would have to deal with any brand and any model that comes along.

G.L.(Hornsby, NSW)

I have quoted only that part of the letter which relates to service charges, and that is about as much as we can accommodate here conveniently. In the rest of the letter, G.L. comments caustically and at length on the conditions which servicemen have to put up with in urban areas, when they are working as employees of a large servicing organisation, or a department store or a manufacturer.

They are under pressure to get through as many calls per day as they can, even when it means working through lunch breaks and outside the theoretical start and finish times. Their standing with bosses and customers alike is poor and every day is a round of complaints from both sides. Little wonder, says G.L., that he and many others like him have taken the first opportunity to get out of the TV service rat race!

But, in saying this, of course, G.L. brands himself as non-typical of self-employed serviceman and while he says he has all the necessary equipment to operate on his own, he is actually working full time outside the TV service industry. His ideas may therefore be coloured more by deduction than by prolonged experience in the one-man-business role.

However, I did put his ideas to the business adviser who was behind the original "Serviceman" article. He confirmed that a service business (any kind of service) can logically move on to a quote-for-the-job basis provided:

(1) The operator(s) understand the job, the area and the clientele well enough to be able to strike a reasonably accurate

average for the commitment involved; and

(2) the involvement for the class of job is related back to man-hour costs, as already discussed, to generate a reasonable quote.

As an example of the principle in practice, he quoted the automotive industry, which is constantly being faced with requests to mend punctures, replace tyres, re-line brakes, replace generators, etc. The jobs are sufficiently routine for service departments to be able to give a firm quote for most jobs, knowing that a substantial profit on the easy ones will be trimmed back by the jobs where nuts are rusted solid!

Whether a one-man TV service business can operate on this basis, when faced with all kinds of problems on all kinds of sets, is another matter.

I know some have, in the past, and the tales of alleged rip-offs are legendary.

One approach was (maybe still is) to "diagnose" all kinds of dreadful faults which "really should be fixed" and to quote a figure which would cover "a thorough overhaul". The serviceman could hardly lose on the job of fixing the genuine fault; whether he did any work beyond the actual fault could be the subject of considerable argument.

In championing the idea of quote-for-the-job G.L. is therefore venturing into an old minefield, raising the whole question of how realistic quotes can be for repair work on a wide range of TV sets and maybe other electronic gear.

And I wonder also about G.L.'s insistence on taking all but the simplest cases back to the workshop. One can appreciate the arguments as stated, and the fact that he may be reacting against the reverse pressure which has traditionally been on men employed by service organisations.

But the necessity for a return journey in so many cases and the automatic charge that G.L. suggests for it, makes it look as though the serviceman is gaining more from his four journeys per day than from fixing two sets!

But then again, G.L. may be making a right point for what might seem, superficially, to be the wrong reasons. As distinct from the days of monochrome TV, the proportion of journeys back to the service bench would appear to have risen steeply.

While modern colour sets break down much less frequently than the old monochrome valve sets, when they do fail, they do so for much less accessible reasons. The serviceman can no longer plug in a new valve and call the job done. Nor can he count too heavily on having replacement modules on hand. More often than not, the bits he may want to check or replace are soldered in and there's not much future in blindly trying this and trying that!

Maybe we should leave the subject open at that point for self-employed servicemen to relate their own findings. ☺

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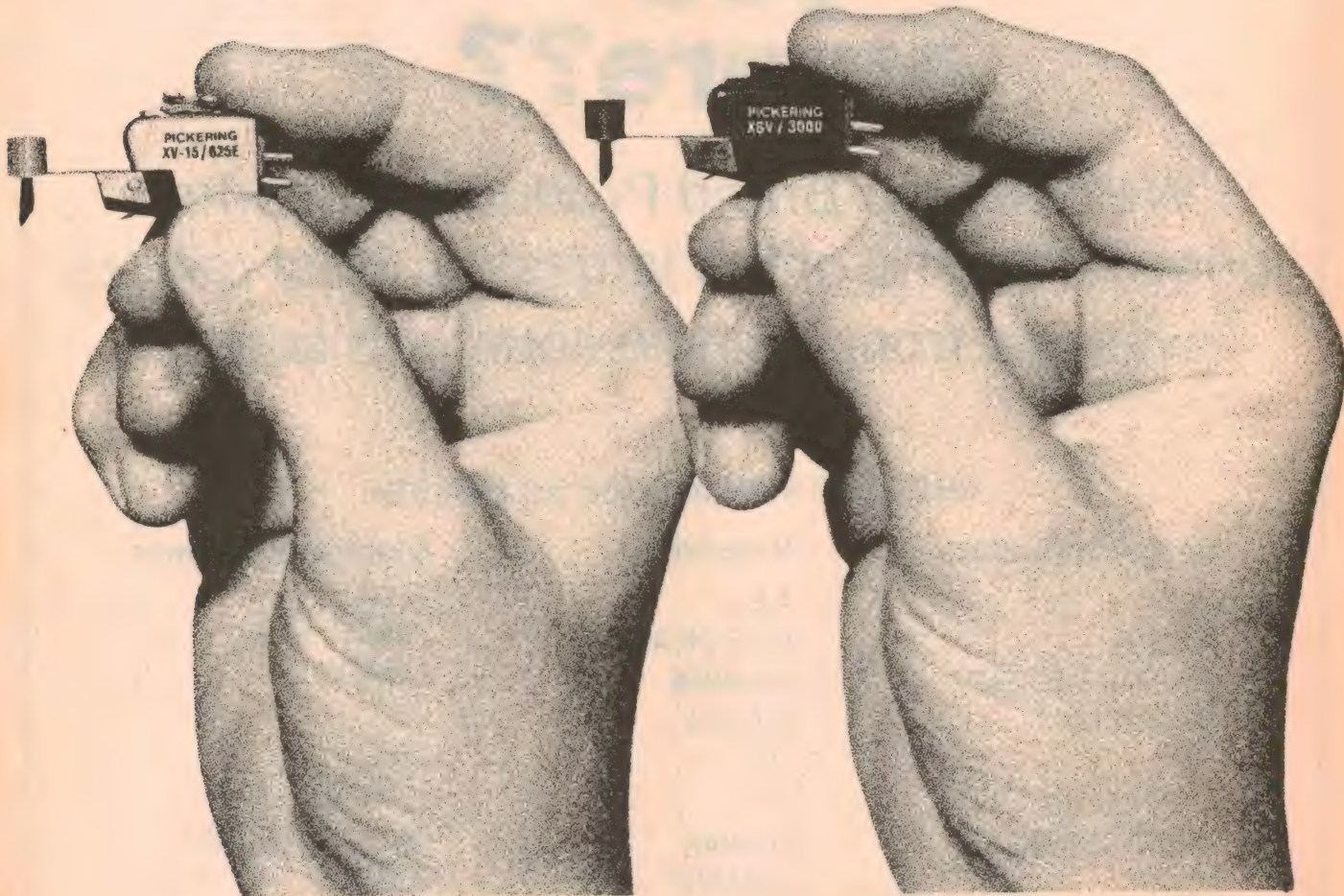
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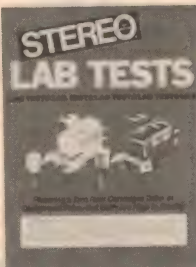
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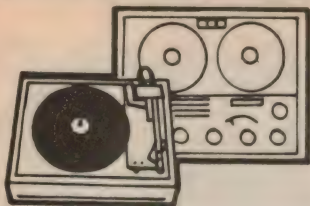
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Hi Fi News

Heathrow: a glimpse of what's ahead

This year's HIGH FIDELITY '77 SPRING EXHIBITION held at the Heathrow Hotel in London saw a record number of exhibitors, brand names and new products. John Penhallow of Auriema (A'Asia) Pty. Ltd. reports on some of the show's highlights.

PIONEER & SONY occupied the lower ground conference rooms and, true to form, presented us with very impressive displays of equipment.

The most interesting new item from PIONEER was a 4-channel tape deck, the RTU-11 which, with optional TA-11 pre-amps, provided for four channels of synchronised multi-tracking. It features a 3-motor transport, user adjustable bias and equalisation controls and a built-in oscillator. Surely an ideal tape machine for the serious home recordist!

Also new and interesting was the RT-707, a rack-mounting auto-reverse tape deck. Small in size (it only takes 7" spools) it would be a handy unit for tape copying and dubbing.

On the electronics side, PIONEER were showing off their new range of quartz controlled direct-drive turntables and a new class-A transistorised power amplifier, the M-22, which at 30 watts

RMS per channel at 0.008% THD weighed a hefty 60lbs! Finally, they displayed a new loudspeaker system, flown in especially from Japan, the HPM150. This is a 15" 3-way system utilising a polymer horn-loaded super tweeter to achieve a claimed high frequency dispersion of 360 degrees.

Meanwhile, over at SONY again, the most interesting new products on show were the Elcaset and other new tape decks.

There was the portable TC-51021-2 with vari-speed (great for "on-location" recordings) plus two 3-motor machines, the TC-765 and the TC-766-2. The former a low-speed quarter-track 3-head unit, and the latter a high-speed half-track model with a fourth head for quarter track playback only.

Two other interesting products shown by SONY were a Pre-amp/Power-amp combination so new that they didn't even



Above: Three new models of dbx noise reducing systems, shown at Heathrow. Model 128 in the centre is a stereo unit, designed for the enthusiast market.



Left: Ordinary stereo signals, processed through the Audio Pulse Digital Time Delay System, and fed to rear loudspeakers through the amplifier on which it is resting, produced an impressively spacious sound.

have model numbers! The power amplifier was SONY's brand new PWM (Pulse Width Modulation) amplifier using complementary V-FET's to achieve 160 watts RMS per channel in a slim, light, 19" rack mounted format.

The Pre-amp, was notable for the absence of tone controls, the combination being intended primarily for professional use.

On the ballroom floor, JVC were demonstrating QB-phonics—a research prototype system surround sound while, up on the 1st floor, the N.A.D. distributor

was exhibiting the new American Audio Pulse Model One digital time delay reverberation unit. It is designed to recreate the multi-directional sound paths found in concert halls. A track from "Peter Frampton Comes Alive" really did, when played through this device using a second stereo amplifier and two small inexpensive speakers for the rear channels. The listening room appeared to be as audibly large as the stadium the album was recorded at!

Next stop was Strathearn Audio, a new manufacturer, producing a range of belt and direct-drive turntables in Belfast. Despite early production teething problems, the company's products are selling well in the U.K. and they hope to be represented in Australia by Christmas.

There was, of course, a proliferation of large and small British loudspeaker manufacturers at the show.

One of the large ones, KEF unveiled to the press a very impressive Reference 105. It's a new style for KEF, with separate "in-line" enclosures for each of the three drive units. The system features a small lamp, cunningly positioned, so that when visible it indicates to the listener that they are in the stereo listening field! Power handling is 40-80 watts RMS with a claimed response of 30Hz-25kHz.

CELESTION presented their latest addition, the Ditton 22, an 8" 3-way system that fits into their range between the Ditton 15 and Ditton 33.

MONITOR AUDIO showed off their new "Super-Seven" bookshelf model, but probably the most exciting new manufacturer was CHARTWELL with its range of four loudspeaker systems built to BBC specifications by ex-BBC designers and Technicians. Angus Mackenzie, the highly respected British Audio journalist was so enthusiastic about them that he prepared a special demonstration tape that was truly demanding of any speaker and certainly proved his point.

Of the remaining loudspeaker exhibitors, SPLENDOR plus new names CELEF and CASTLE ACOUSTICS were well worth a long listen.

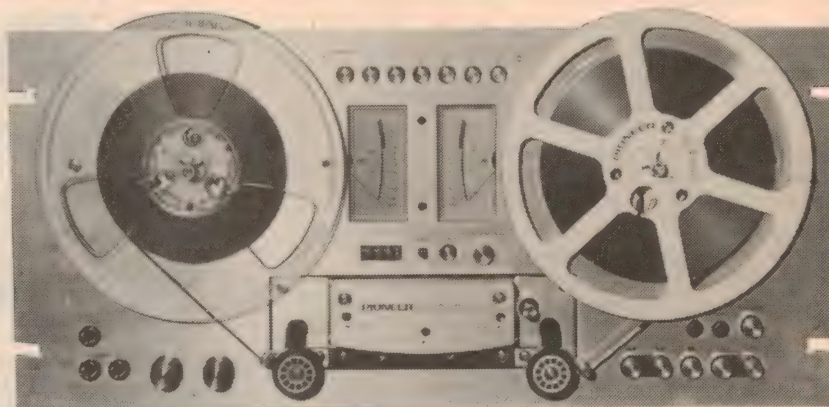
On the electronics side, LUX introduced their LUX Laboratory Reference Series, including the SM 21 and the MQ3600 all-valve power amplifiers at 100 and 50 watts RMS per channel respectively.

NAKAMICHI had a new power amplifier—the 420—at 50 watts RMS per channel. The outputs can be bridged with their BA-100 bridging adaptor for mono operation, achieving 120 watts RMS! The

NEW CLASS-D AMPLIFIER BY SONY



The display at Heathrow showing Sony's new PWM amplifier. Cards on the stand explained it as: "As a new amplifier using complementary vertical field effect transistors to achieve 160W RMS per channel. A normal class-B hifi amplifier would need to be approximately four times bigger, six times heavier and consume almost three times the power under normal conditions to produce the same power output. It would also generate around 1kW of waste heat". The pattern on the double-beam oscilloscope showed a sine-wave input and raw output from the amplifier, with pulses of uniform height but width varying from maximum (upper sine wave peak) to minimum (lower sine wave peak).



Compact and obviously intended for rack mounting, this new RT-707 open-reel deck by Pioneer would appear to be aimed mainly at the professional market.



Conservative to the point of severity in its appearance, this new TEAC "Esoteric Series" 860 is the first ever cassette deck to incorporate dbx II noise reduction in addition to Dolby. It provides a wide range of facilities including 4-channel input mixer, plus master, each with left-right pan, and switchable for mic or line input—very much a unit for the professional or the enthusiast!

QUANTUM by MEMOREX

Professional Performance

Quantum surpasses other leading premium open reel tapes in overall recording performance. Specific performance advantages offered by Quantum include:

Greater Sensitivity.

Quantum offers several dBs more output than other premium open reel tapes for the same record drive.

Lower Distortion.

Quantum offers lower third harmonic distortion (THD) than other premium open reel tapes.

Better Signal/Noise Ratio.

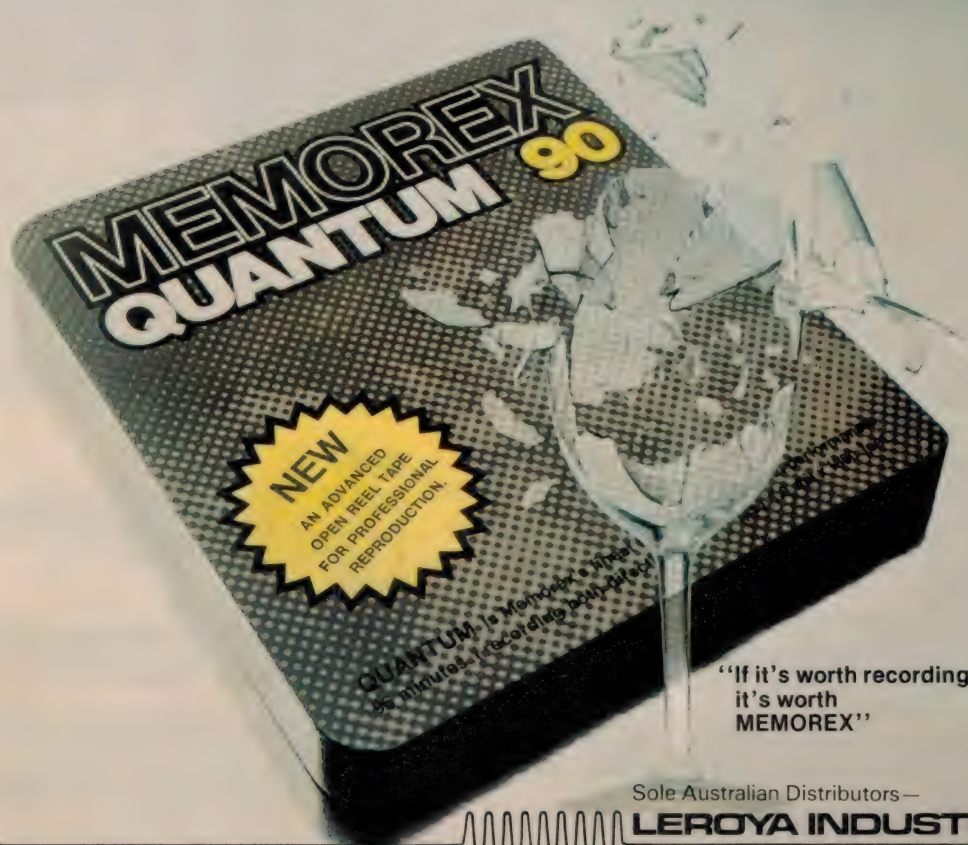
Quantum offers up to several dBs more output at 3% THD, and because Quantum has more output and greater sensitivity with no increase in noise, the signal/noise

ratio is greater than other premium open reel tapes.

Higher 10 KHz Saturated Output.

Quantum offers up to several dBs more saturated 10 KHz output than other premium open reel tapes, thereby providing greater dynamic range.

All these performance characteristics add up to the best premium open reel tape widely available. Testing supports this promise. Memorex Quantum has been tested against other leading premium open reel tapes, and has outperformed them all.



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SB-5000

SB-4500

SB-6000

The amazing waveform fidelity of Technics linear phase 2-way speaker systems is now almost legendary. To achieve sound that is virtually indistinguishable from the original, Technics research developed the linear phase system by adopting high performance, wide range units in a unique network configuration and ideal positional location.

With the Technics SB-4500 comes a similar system—priced to suit the economy minded. It retains the essential crisp transparency of sound all the way through the audio spectrum, easily handling peak power of up to 75 watts.

Technics also offer the SB-5000 and SB-6000 linear phase speaker systems for high fidelity components of compatible quality and performance.

SB-4500

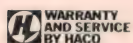
- Extra wide-range 25 cm cone-type woofer.
- 6 cm wide-range edgeless cone tweeter eliminates edge resonance and so reduces distortion • 75 watts peak power input.
- 92.5 dB/W (1 m) sound pressure level.

SB-5000

- Wide range 25 cm woofer.
- 6 cm wide-range edgeless cone tweeter delivers a crisp transparency of high frequency sound • 75 watts peak power input.
- 93.5 dB/W (1 m) sound pressure level.

SB-6000

- 30 cm woofer gives low distortion from super-low frequencies through the midrange.
- 3.2 cm dome tweeter gives high efficiency and low distortion.
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Features include:

10MHZ, 8 x 10 cm display. Can be used in Single Trace, Dual Trace and X - Y modes. Automatically selects for chopped or alternate modes. Automatically selects for TV line or frame displays. Contact Tektronix for a demonstration or specification literature.

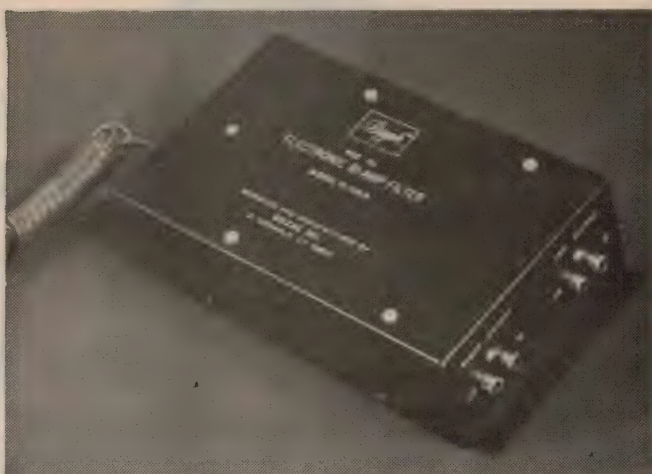


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HIFI NEWS—continued



Normal practice with hifi-stereo systems is to feed the output from each power amplifier to its associated loudspeaker system, leaving it to a passive network in the enclosure to frequency divide the signal, and feed it to the appropriate transducers: woofer, squawker and tweeter. However, Bozak Inc. claim that superior results can be obtained by performing the frequency division after the preamplifier, using entirely separate power amplifiers to drive the speakers. The unit pictured above, model N-106B is intended for use with home stereo systems, dividing the spectrum into two channels crossing over at 400Hz. For details: Bozak Australia Pty Ltd, 5 Birdum St, Moorabbin, Vic 3189.

420 when combined with matching Pre-Amplifier, the 410 has a more conventional appeal than the 600 series.

However from the 600 series came another new Nakamichi product—the 630 FM tuner-preamplifier. It has features like a variable contour control, Dolby N.R. and unique tuning indicators that show centre tuning, tuning direction, stereo station and signal strength. Combine these with the "instrument-type" tuning dial, and selecting a station was very easy indeed.

S.A.E. showed off their Model 5000 noise reduction unit which electronically removes the sounds of scratches from your records—for a price!

Q.E.D. Passive Tape Switching Unit

Pictured below is a simple gadget but one which could be of assistance to enthusiasts who need to interconnect and use a greater number of tape decks than their amplifier will accommodate. Fitted with 4 DIN sockets and two switches, it can directly accommodate three decks, allowing any one to be selected as the source of signal and any (or all) to accept a signal for recording. Direct deck-to-deck routing is also possible, provided their respective output/input levels and impedances are compatible. The distributors point out that, once the patching is set up, the user is relieved thereafter of

the tedious job of swapping leads; it's just a matter of clicking switches. Price quoted for the Tape Switching Unit is \$32 plus \$1 pack & post, plus 50c if certified mail insurance is required. For further details: M.R. Acoustics, P.O. Box 110 Albion, Qld 4010.

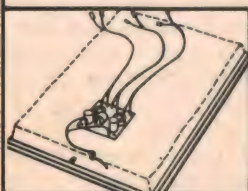




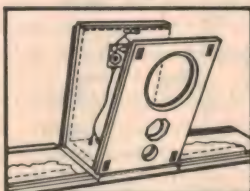
Save on top quality European speakers

– assemble your own system with this – complete Philips kit.

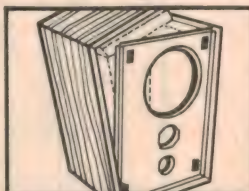
All you need is a couple of hours, a pair of scissors and a screwdriver.



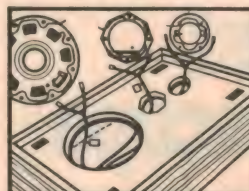
1 Screw the crossover networks to the baffle boards.



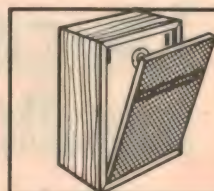
2 Apply glue to the case and fit baffle boards in grooves.



3 Wrap sides of case around baffle board.



4 Insert speakers in holes and screw into position.



5 Clip fascia panel in place.



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New quartz-PLL servo system turntable from PIONEER

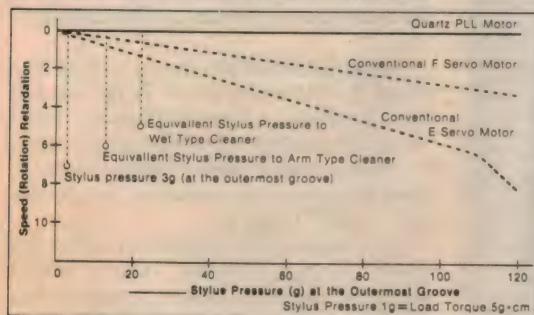
At first glance, the Pioneer PL-550 is much like any other quality turntable but, inside, there is an important difference.



Heading up an already impressive array of high quality turntables, Pioneer's new PL-550 sets new standards for the enthusiast market with a wow and flutter rating of 0.025% (RMS), a signal/noise ratio of 70dB (DIN B) and temperature and time drift figures of .00004% and .0003% respectively.

The basic motor is a high-torque direct-drive type which can bring the turntable up to full speed within considerably less than one revolution. As it accelerates, the speed of the turntable is registered by an impulse generator attached to the rotor shaft and the output

Load Characteristics of D.D. Turntable



of this is compared first in terms of frequency, then in terms of phase, with the output from a quartz crystal-locked reference oscillator. An array of electronic circuitry, mounted on a PC board, makes the comparison and modifies the drive to the motor to hold it in precise step with the reference oscillator.

The high torque of the motor and the precision of the regulation system not only ensures that the turntable comes up to speed very rapidly, but also allows speed change between 33 and 45rpm without protracted speed hunting. It also renders the turntable virtually insensitive

to the effects of drag due to the stylus or to record-cleaning devices, as indicated in the accompanying graph.

A precision statically balanced S-shape arm is fitted capable of accommodating cartridges weighing between 4 and 14.5 grams and provided with adjustable anti-skating bias.

For further details: Pioneer Electronics Australia Pty Ltd, 178-184 Boundary Rd, Braeside Vic 3195.

HEATHROW—continued

Talking about noise reduction, TEAC had the A-860, the world's first cassette deck with dbx noise reduction. It has 3 motors, 3-head dual-capstan drive, Dolby N.R. as well as dbxII, and a host of other features too numerous to mention. This deck does everything except make the tea! The British TEAC distributor also handles dbx products and was showing the three new dbx products just arrived from the States, the 118, 128 and the 3bx, all due shortly in Australia.

Finally, I left the show thinking I'd seen everything, when, outside the main entrance was the TEAC/TASCAM mobile recording truck. Fitted out with TEAC multi-tracking tape equipment, the balance engineers were demonstrating a mix-down procedure from the TEAC 80/8 eight channel deck to an A-3300SD Stereo deck.

PLESSEY AUDIO FADER

A new professional linear motion conductive plastic fader has been introduced to the Australian audio industry by its sole agents, Studio Electronics Pty Ltd, Burwood North, NSW.

Developed and manufactured in the United Kingdom by Plessey Resistors, Type FM 4 has first-class applications for sound control and fade in recording, television and broadcasting studios.

The new Plessey product has all the facilities associated with this group of instruments, including precision-ground rods which align the wipers and provide an extremely smooth motion.

The mono or stereo Type FM has conductive plastic tracks, smooth, silent action, is rugged, compact and reliable with a long, noise-free life.

Resistance is 10k (audio taper), insertion loss less than 1dB.

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Nakamichi 630 combines a high performance tuner and a control preamplifier

In spite of the deluge of new models constantly appearing in the hifi market there are few that represent new product concepts. The Nakamichi 630 is an exception to this rule. It combines a high performance FM stereo multiplex tuner together with a complete stereo control preamplifier.

Why not a receiver instead? Nakamichi have posed this question in their own literature and answered it by stating that a high performance, high power stereo receiver would have to be very bulky and may involve undesirable compromises.

While many may argue with the latter proposition it is a fact that the Nakamichi 630 is a logical continuation of the 600 series. The 600 series began with the Nakamichi 600 cassette deck (reviewed

We should note, at the outset, that our frontal photograph does not really do justice to the 630. In the metal, it is a very striking unit which brought favourable comment from all who saw it.

Apart from its relation to the rest of the Nakamichi 600 series, the 630 bears no resemblance to other preamplifiers or tuners. As a tuner it is especially different from its competitors. No AM reception is provided—Nakamichi have put quality

Finally, a red "centre tuning" LED lights to show that the tuning is on the button. After a delay of about half a second the tuner unmutes and the signal can be heard. A stereo beacon lights to indicate stereo reception.

Three push-buttons select the FM reception mode. The "Dolby NR" button switches in B-type Dolby decoding circuitry as well as the 25 microsecond deemphasis for proper reception of Dolby broadcasts. The "mute" button sets a signal strength threshold of about 30 microvolts (at the 300 ohm terminals). Signals below this threshold can be received by depressing the "mute" button.

For signals below 300uV, the "Signal" LED is extinguished. So while this LED remains alight the signal quality should be good. For signals below 30uV the centre tuning LED is also extinguished. For accurate tuning below this threshold, the muting button must again be depressed.

Signal threshold for stereo reception is about 2 microvolts which is far too low for satisfactory signal-to-noise ratio. These weak stereo signals can be heard in mono, giving about 35dB improvement in signal-to-noise ratio, by pressing the "mode" button.

One feature not found on other FM tuners is the "narrow" button which increases the selectivity from better than 45dB to better than 90dB. (We assume these figures are for adjacent channel selectivity, which refers to a channel spacing of 400kHz.) This is a handy feature when there is interference between a strong and a weak station which are close together. This very situation existed in Sydney up until a few months ago.

Five pushbuttons provide for monitoring or dubbing from two tape or cassette recorders.

A loudness switch is not to be found on the 630 and that we'll not complain about. In its place is the "contour" knob. This functions as a sort of secondary volume control with a range of about 30dB. As the knob is rotated anticlockwise to reduce the signal level bass and treble boost is applied. This provides a variable loudness compensation.

This may be regarded as more desirable than the fixed compensation provided by the usual Loudness switch.



in "Electronics Australia", July 1976) and expanded with the 610 Control Preamplifier and the 620 stereo amplifier which were reviewed as part of the Nakamichi System-One in the "Electronics Australia 1976 Yearbook".

As such, the 630 will have considerable appeal to those who wish to base their stereo system on a separate high power amplifier and have the need for a preamplifier and tuner. Combining the tuner and preamplifier in the one case is logical and is likely to start a trend amongst competing manufacturers.

AM reception in the "too-hard" basket and instead providing a mediocre AM section they have eliminated it entirely. Fair enough, too.

Instead of the usual illuminated "slide rule" dial, the 630 has a large circular rotating dial with an edge-lit cursor. Tuning meters are also absent. In their place, five LEDs indicate the signal conditions. First of all, the "SIGNAL" indicator lights to show that the tuning is in the "ball-park" of a signal. As tuning gets closer one of two green LEDs indicates whether the tuning is high or low.

However we are inclined to regard any sort of Loudness compensation as unnatural.

The 630 incorporates its own stereo headphone amplifier which provides a maximum of 300 milliwatts per channel into 8 ohm phones. Use of the headphones removes the output to the following stereo amplifier. The contour facility does not act on the headphone amplifier.

Like the other units in the 600 series, the 630 is designed to mount on a horizontal surface so that its control panel has a slope of about 35 degrees. Alternatively, the 630 can be rack mounted. These two mounting methods mean that the cross-section of the 630 is roughly triangular, so the internal layout is rather unusual.

Our photograph of the interior of the Nakamichi gives some idea of the complicated internal layout. At one end of the chassis is the power supply PC board while at the other end is the phono preamp PCB. In between, one half of the chassis volume is taken up with the FM tuner circuitry, with front-end module, IF module and multiplex decoder PCB. The rest of the volume is taken with a multiplicity of PC boards (some not visible) for the high level circuitry such as the tone controls, headphone amplifiers and so on. All PCB interconnections are made via miniature edge connectors. Clearly, accessibility is not one of the 630's strong points. Re-stringing the dial cord might be a little tricky!

We found the large number of electrolytic capacitors in the circuit a little disturbing. While it is true that reliability of electrolytic capacitors is greatly improved over former years, we would still prefer to see the number cut to a minimum.

As with a number of Japanese receivers we have seen, the tone controls appear to be rotary switches but are in fact dual potentiometers with a detented backing plate which provides the switch action. The balance control potentiometer has a similar detent in its backing plate to provide a definite centre setting.

Input facilities are provided for magnetic cartridge, two tape or cassette recorders and one auxiliary source such as a TV receiver. Sensitivity of the magnetic cartridge input is adjustable by means of a slide switch with settings: 1mV, 2mV and 5mV. Increasing the sensitivity lowers the overload margin.

We were a little surprised to note that the input load for the cartridge inputs is 100k instead of the more universal value of 50k. To our knowledge, relatively few cartridges are designed for a load of 100k and most of those would be intended for CD-4 operation. We wonder why the input load is not switchable, as in the 610 model.

No circuit diagram was available at the time of writing this review so we are unable to comment on details of the circuitry.

However, we understand that the phono preamplifier section is very similar to that used in the 610 and 410 preamplifier control units. This is most unusual in that it uses a "triple transistor" (three transistors connected in parallel) in the critical first stage.

The idea behind the "triple transistor" concept is to produce a transistor with a very low internal impedance. This is supposed to produce the absolute minimum input noise and thus the best signal-to-noise ratio. Nakamichi quote a weighted signal-to-noise ratio of 80dB with respect to 1mV. We assume that this is with short-circuit inputs. Our test result for this input condition was 69dB unweighted.

In practice, with low noise preamplifiers like this design, the limiting factor in actual signal-to-noise ratio is the cartridge itself. Its source impedance hum pick-up and characteristic noise voltage combine to produce a signal-to-noise ratio which can be considerably degraded to that produced with a short circuit input. But who listens with short circuit inputs?

Our practice is to use a standard magnetic cartridge (Shure M55E) in a turntable which is earthed but not connected to the 240VAC mains, with all AC wiring and hum fields kept to a minimum. The effective input noise signal is then referred to an input signal of 10 millivolts. The resultant unweighted signal-to-noise ratio can then be directly compared with other preamplifiers or amplifiers.

amplifiers can be switched without the slightest click.

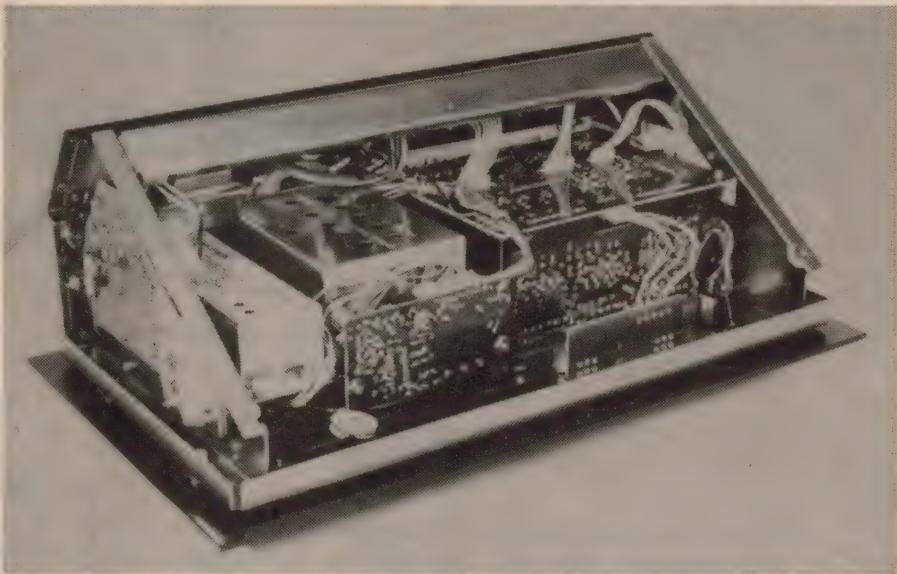
All the controls operated very smoothly, which contributed to the sense of operating refinement. We did note that the tuning knob tended to run a little "off centre" though.

The bass and treble controls appeared to have very little effect and this is explained by the modest figures quoted. Bass boost and cut is quoted at ± 9 dB at 20Hz while treble boost and cut is ± 9 dB at 20kHz. When translated to frequencies which are audible and oft-occurring, the bass control gives ± 4 dB at 100Hz, $\pm 7\frac{1}{2}$ dB at 50Hz and the treble control gives ± 7 dB at 10kHz.

While the combined effect of the tone controls plus the contour control can add up to a substantial amount of bass boost we tend to favour tone controls with more apparent effect while dispensing with the contour control.

Frequency response of the high level inputs (aux and tape monitor) was within 1dB from 5Hz to 300kHz. That seems rather extended. We would prefer to see some rolloff in response at a lower frequency, says 30kHz, to avoid possible problems with transient intermodulation distortion in the following amplifier.

RIAA equalisation was within 0.3dB from 20kHz to 30Hz with -0.5 dB deviation at 20Hz. Overload margin for the phono inputs is quite generous: 120mV at 1kHz for the 2mV setting and 300mV at the same frequency for the 5mV setting. Maximum output signal from the



Beautifully finished PCB's and neat wiring are hidden features of the Nakamichi 630.

Our appraisal of the 630 began with listening tests and these impressed us with its operating refinement. It is very quiet at all times and is not troubled with switch-on or switch-off thumps, mains interference or RF interference. The unit is muted for a short period after switch-on and unmutes very smoothly. The same can be said of the FM muting. Even the sensitivity of the phono pre-

preamplifier is 5.8 volts RMS.

Signal-to-noise ratio for the phono input was 74dB unweighted with respect to a 10mV input and the reference 1V output, with a typical cartridge connected. For the high level inputs the S/N ratio was also 74dB unweighted with respect to 100mV input and 1V output. This figure was obtained with a 4.7k resistor loading the inputs.



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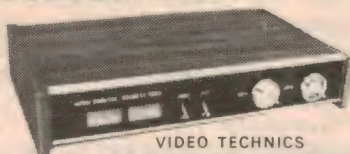
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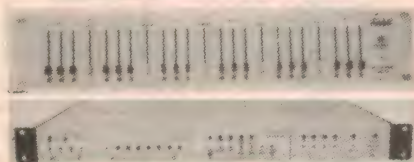
Announcing our video focus intensifier to improve the playback quality of all VCR system video recorders.

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This circuit detects a change in picture contrast and inserts a transient—in effect an extra—signal at this point, which crispens the image. The effect if the size of this transient is adequate is to recover lost sharpness, and the principle is indeed very effective. Full fitting instructions included.

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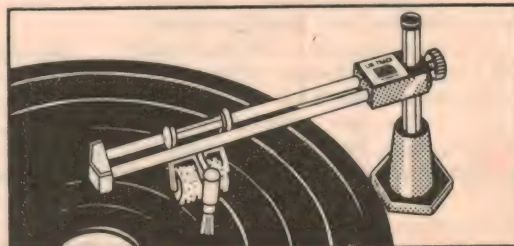
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NAKAMICHI 630 TUNER PREAMPLIFIER

Separation between channels (for the preamp) was 38dB at 10kHz, 56dB at 1kHz and 67dB at 100Hz with a 4.7k resistor connected to the input. Short-circuiting the undriven input improves the figures to 49dB, 68dB and 69dB respectively.

Harmonic distortion is quoted at less than .003% for all inputs. Certainly it is well below the distortion threshold of our measurement equipment.

So far then, the preamplifier, can be seen to offer excellent performance, but to be realistic, there are quite a few systems which offer at least equivalent performance. It is the tuner in the 630 which really sets it apart from its competitors.

There is nothing unusual in the Quiet-ing curves of the 630 tuner—many other turners can equal or better it in this respect. Ultimate signal to noise ratio was 64dB in mono and 63dB in stereo. Limiting is complete at 10 microvolts.

Now have a look at the frequency response and separation between channels curves. No, that is not in error. The separation was a maximum of 55dB in both directions at 2kHz and 50dB or better over the range 300Hz to 3kHz. That is by far the best result we have ever measured. Note that this figure is only a few dB less than that for the signal-to-noise ratio.

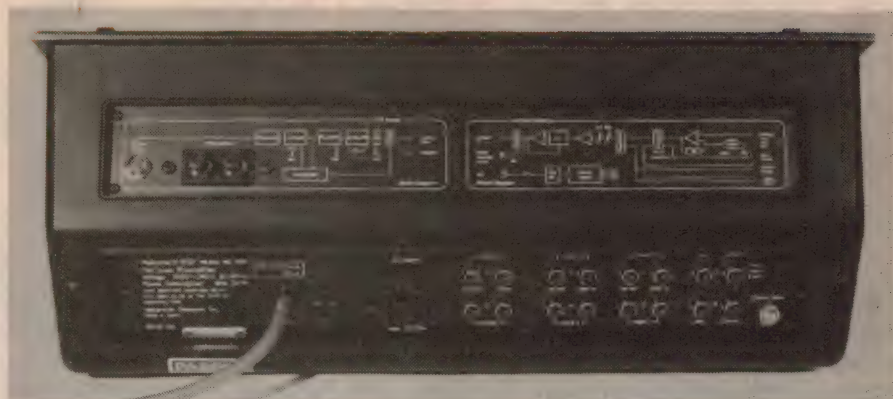
Switching to the narrow selectivity mode does reduce the separation, but even so it is still quite respectable at better than 30dB.

19kHz residual is quoted as minus 70dB with respect to full modulation. That is well below the residual noise level and unmeasurable as far as we are concerned.

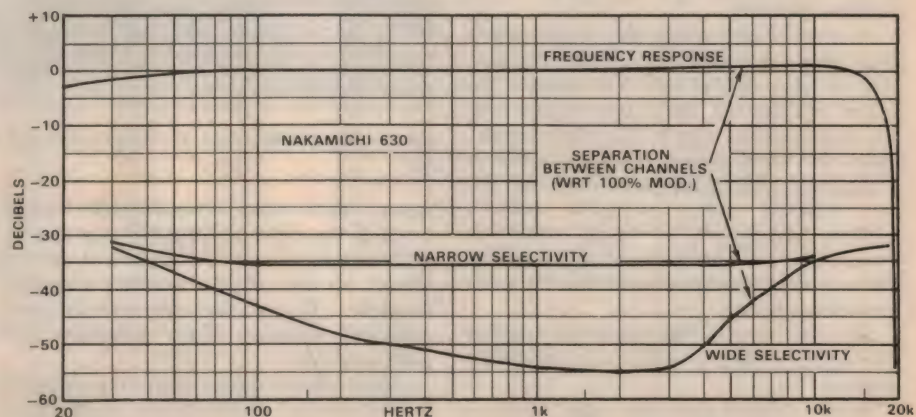
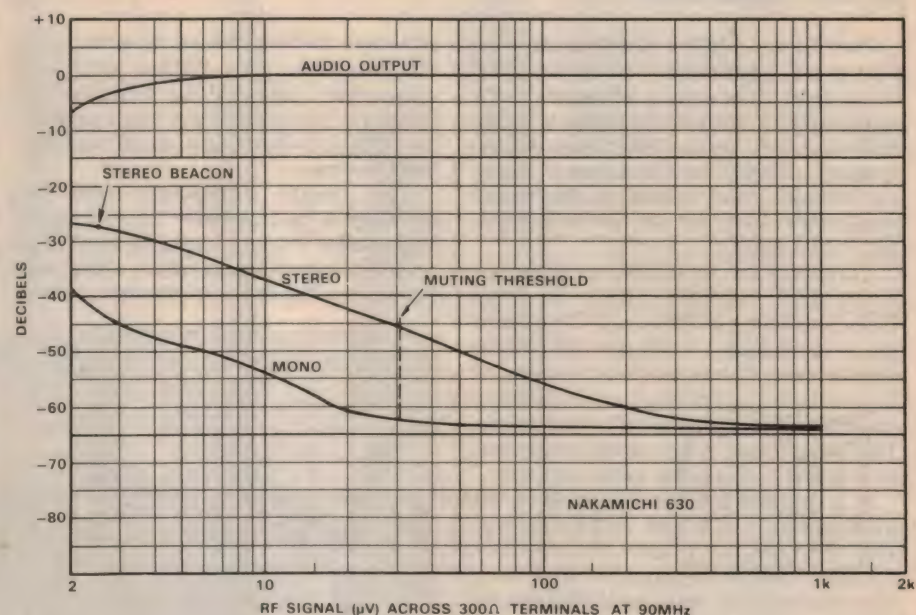
Harmonic distortion is quoted for both the wide and narrow selectivity settings for 100% modulation at 400Hz. For the narrow mode, we obtained mono distortion readings of 0.3% at 100Hz, 0.24% at 1kHz and 0.22% at 6kHz while in stereo the respective readings were 0.6%, 0.5% and 0.3%. Switching to the Wide mode does little to the mono distortion figures but gives a big improvement to the stereo figures. In mono we obtained 0.3% at 100Hz, 0.2% at 1kHz and 0.27% at 6kHz.

With wide selectivity, the stereo harmonic distortion figures are 0.15% at 100Hz, 0.12% at 1kHz and 0.2% at 6kHz. These figures are not as good as the excellent figures claimed by Nakamichi, but they still represent the best overall harmonic distortion figures we have measured to date.

Because of variable program quality it is difficult to assess the sound reproduction from FM stations but our own "off-air" music signals provided via the Sound Technology 1000A/1100A test set were indistinguishable from the same disc



The rear panel of the Nakamichi 630 features two block diagrams which show circuit functions.



programs fed into the phono inputs. Clearly the 630 tuner section will have negligible effect on program quality provided signal strength is reasonable.

Overall, the Nakamichi 630 is a most impressive piece of equipment with

many innovations which are likely to be copied. Further information can be obtained from the Australian distributors for Nakamichi equipment, Convoy International Pty Ltd, 4 Dowling Street, Woolloomooloo, NSW. (L.D.S.)

Increase your sense of security with a 10GHz Radar Burglar Alarm



This simple microwave unit will detect moving objects at up to ten metres range. It employs the Philips CL8963 Doppler module and a circuit comprising two integrated circuits and four transistors. Everything is mounted on a small PC board and housed in an economical plastic box.

by LEO SIMPSON

The Philips CL8963 Doppler module has many applications involving the detection of moving objects. Such applications include burglar alarms, door-openers, automobile anti-collision systems, aids for the blind, batch counting systems, and speed measurement equipment. (No, we are not alluding to the Police radar.)

Contained in the CL8963 module is a Gunn diode which oscillates at 10.525 Gigahertz with a 7VDC supply. The Gunn diode is mounted in a tuned microwave cavity which has a small range of frequency adjustment via a small screw inserted about halfway along the cavity. This adjustment is set during manufacture and should not be tampered with.

In a separate microwave cavity is the mixer diode which acts as the receiver. The transmitter (Gunn diode) and receiver cavities are coupled to a common transmitting and receiving antenna, which is a small straight-sided horn. This provides a 5dB gain and a modest degree of directionality.

In normal operation, the Gunn diode transmits a beam of microwave energy. Any moving object which intercepts the beam will reflect some energy back to the antenna and thus to the mixer diode. The moving object will cause a frequency shift (Doppler effect) in the reflected wave which, when heterodyned with the local oscillator frequency, will produce an appropriate AC signal superimposed on the DC output of the mixer.

The AC signal is filtered and amplified and used to trip a relay or some other device.

Power output from the Gunn diode is a miniscule 8 milliwatts so there is no danger of injury from exposure to the microwave energy. If you were thinking of curdling the brains of unsuspecting burglars, this is not the way to go!

A circuit featuring the Philips CL8960 (now CL8963) was published in the May 1975 issue of "Electronics Australia".

However this was based on preliminary information from Philips and was, apparently, not entirely trouble-free. Other circuits which have been available to hobbyists have also been less than trouble-free.

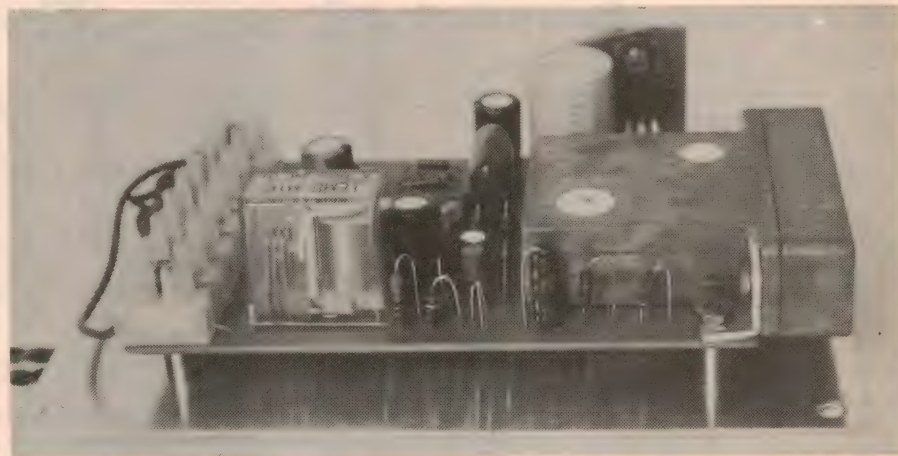
The circuit published here was developed by Electronic Developments and Service Pty Ltd. Its publication is the result of liaison between EDS, Dick Smith Electronics Pty Ltd and "Electronics Aus-

Here is the prototype burglar alarm disguised as a plastic box.

may be made to latch in the off condition. In the latter condition, the unit may be the basis of a simple burglar alarm system. Better still, it can function as one of the sensors in a more comprehensive burglar alarm system.

Apart from burglar alarms, another possible application for the circuit is for an automatic lighting system. Visitors to a residence could be detected as they walk up the path to enable garden and entry-way lights to illuminate automatically. This system would also have value in deterring intruders.

Compared with earlier designs, this



When the plastic box is fitted over the alarm assembly it provides a splashproof lid.

tralia". EDS have considerable experience in the field of industrial electronics and have developed a number of circuits based on the Philips CL8963 Doppler module. These include simple and complex burglar alarm systems and door-openers.

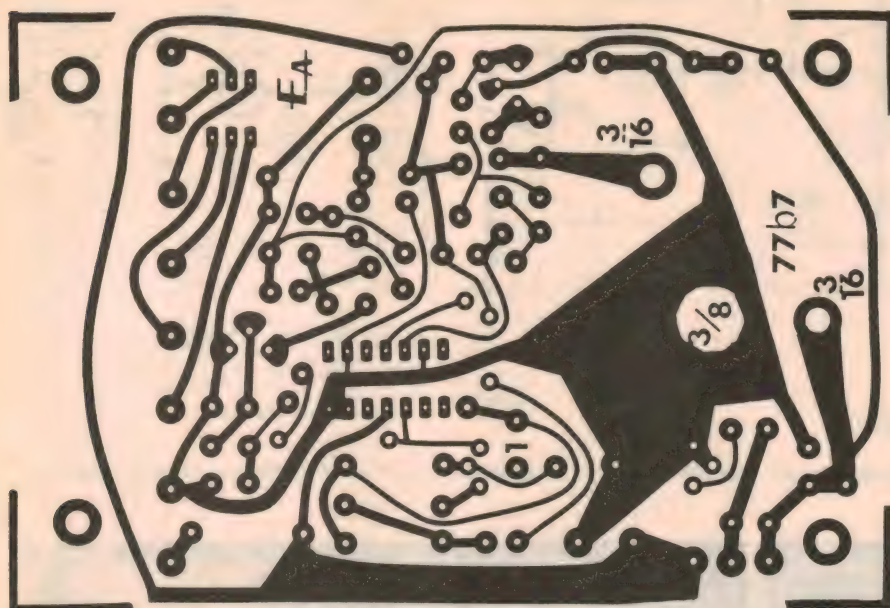
(Note: Those interested in commercial and industrial applications of Doppler modules should contact Electronic Developments and Service Pty Ltd, 27 Buckley Street, Marrickville, NSW 2204.)

As presented, the circuit uses a CL8963 to control a relay with DPDT contacts. Normally the relay is energised. If a moving body is detected, the relay opens for about 1 second. Alternatively, the relay

circuit is simpler and uses more readily available parts. It is intended to be used with well-filtered DC supplies which may be anywhere from 10 to 16 volts. A 12V car battery, together with a suitable charger, would be quite suitable. Current drain is quite heavy, ranging from about 150 to 200 milliamps.

The power input diode protects the Gunn diode and other circuit components against damage from supply reversal. Combined with the 1000uF electrolytic capacitor it also provides a measure of decoupling from external circuitry. Do not regard this part of the circuit as a rectifier and filter, by the way. The circuit will not work from AC.

10GHz RADAR BURGLAR ALARM



The PCB pattern is 117 x 79mm.

Our method was to double over a piece of 16 SWG aluminium to obtain the required thickness and then to cut and file the resultant piece to shape. The aluminium can be set in place with epoxy adhesive after the CL8963 and its horns are firmly screwed together.

All the components are mounted on the compact PC board. It is coded 77b7 and measures 117 x 79mm. The PCB should have clearance holes for the terminals and adjusting screw and lug on the CL8963 module. In addition, the terminal holes should be chamfered to allow the module to sit down flush with the PCB.

Before mounting any components on the PCB it should be used as a drilling template for the aluminium plate supplied with case (if not supplied already drilled). The PCB should be mounted exactly as shown in the wiring diagram. This shows the PCB with the regulator side positioned 3mm from the edge of the aluminium plate. This position is important otherwise either the regulator heatsink or the CL8963 module will foul the inside of the case.

Make sure that the holes in the insulated terminal block match up with the appropriate holes in the PCB. Note that the sensitivity pot should have an adjustment hole in the PCB and an appropriate clearance hole in the aluminium plate.

Having drilled the aluminium plate, assembly of the PCB can proceed. Leave the CL8963 till last, and do not remove the shorting link from the terminals. Install the horizontally mounted components and wire links first.

If a vertically-mounted 100k preset pot has been supplied instead of a horizontal

type it will be necessary to extend at least the centre lead to enable correct mounting.

While we have designed the copper pattern around 14-pin ICs for the 741, the PC board is also compatible with both the 8-lead "mini-dip" and 8-lead metal can versions of the 741. This is by virtue of the fact that pins 1, 2, 7, 8, 12, 13 and

14 have no internal connection (on the 14-lead IC), while the remaining pins have the same orientation as in the smaller packages.

For both 8-lead packages, pins 1 to 4 connect to pins 3 to 6 of the socket pattern and similarly, pins 5 to 8 should connect to pins 9 to 12 of the socket pattern. The PC board layout diagram shows a mini-dip IC in position.

Low noise cracked carbon or metal film resistors of $\frac{1}{4}W$ to $\frac{1}{2}W$ rating and 5% tolerance should be used throughout. Insert all the resistors so that their colour code bands run in the same direction. Resistors mounted "end-on" should be spaced at least 2mm off the PCB, to avoid damage during soldering.

Ensure that the electrolytic capacitors are correctly inserted, otherwise they will be reverse polarised and rendered ineffective.

The 12V relay mounts directly on the PCB. Ours was branded FEME but an equivalent type from Varley is also available.

The insulated terminal strip should be fitted as follows. Secure a 3mm length of tinned copper wire to each terminal. Bend the wires down uniformly and insert in the holes in the PCB. Locate the terminal strip temporarily with two screws through the PCB holes and solder the wires. Remove the two locating screws. Fit the small heatsink bracket temporarily to the IC regulator.

The PCB is now ready to be checked and the regulator output adjusted to 7V. Solder a resistor of between 56 and 100 ohms with 1W rating across the copper pads for the Gunn diode. Solder another

PARTS LIST

1 plastic case with aluminium lid, 158 x 50 x 96mm.

1 PCB, 77b7, 117 x 79mm

1 8-way insulated terminal strip

1 12V PCB-mounting relay with DPDT contacts (2 changeovers)

1 CL8963 Doppler module

SEMICONDUCTORS

1 LM340T-5 or 7805 5V regulator

1 741 op amp integrated circuit

2 BC549 NPN low noise transistors

2 BC558 PNP silicon transistors

2 1N914, 1N4148 silicon signal diodes

1 1N4001 silicon power diode

CAPACITORS

1 640uF/16VW PC electrolytic

3 100uF/16VW PC electrolytic

1 33uF/10VW PC electrolytic

2 10uF/16VW PC electrolytic

1 0.68uF metallised polyester or polycarbonate

1 .082uF metallised polyester

1 .01uF metallised polyester

1 .001uF metallised polyester or polystyrene

RESISTORS

(5% tolerance, $\frac{1}{4}$ or $\frac{1}{2}W$ unless stated)

2 x 220k, 1 x 150k, 2 x 82k, 3 x 47k 1 x 33k, 1 x 27k, 3 x 10k, 1 x 1.8k 1 x 560 ohms, 1 x 220 ohms, 1 x 56 ohms (1W for setting 7V output), 1 x 27 ohms

1 x 100k miniature preset pot (0.1" mounting centres) horizontal type preferred

MISCELLANEOUS

4 $\frac{3}{16}$ -inch spacers

1 grommet

1 bracket (to secure CL8963)

1 heatsink to suit regulator IC, hookup wire, tinned copper wire, IC regulator mounting hardware, screws, nuts, solder, epoxy adhesive.

Note: A multimeter is required for this project. Capacitors and resistors with higher ratings may be used if physically compatible.

A dwell meter for engine tune-ups

This dwell meter should find ready popularity with Saturday-afternoon mechanics. It will prove handy for making ignition adjustments to your car, helping you to save on service costs and keep your car in a good state of engine tune. It's easy to build too, using just one IC and assembled on a small PC board.

by GREG SWAIN

Next to a tachometer and an ignition timing light, a points dwell meter is perhaps one of the most useful instruments that one could have on hand for engine tune-ups. A dwell meter will enable you to set the ignition points accurately, and also to check on points condition between tune-ups without taking off the distributor cap.

The circuit presented here is based on an application note in the latest "Linear Data Book" put out by National Semiconductor Corporation. All we have done is to make a couple of modifications to the original circuit and design a small PC board to make the unit suitable for home construction.

Before going into the circuit details

though, let's first explain the term "dwell".

Simply stated, dwell is the number of degrees the distributor cam rotates, while the points are closed during each ignition cycle. Most mechanics (both "do-it-yourself" and "professional") set ignition points to the correct dwell angle by rotating the distributor cam until the points rubbing block rests on the top of the lobe, and then setting the gap between the points to a predetermined value with a feeler gauge.

In skilled hands, this method is generally considered adequate, although it does leave something to be desired. The problem is that it's a static test, rather than a dynamic one. If the points do not

open with perfectly parallel surfaces, or if there is pitting of the surface or the feeler gauge is handled incorrectly, it is possible to miss the correct dwell angle by quite a number of degrees.

An electronic dwell meter which allows a reading of dwell angle to be made under dynamic conditions is the most effective means of overcoming these problems. The points gap is simply adjusted until a correct reading is indicated on the meter (or rather the reading falls within the manufacturer's specified range).

Proper dwell adjustment is important if we are to obtain the best possible performance from an engine. There are several reasons for this.

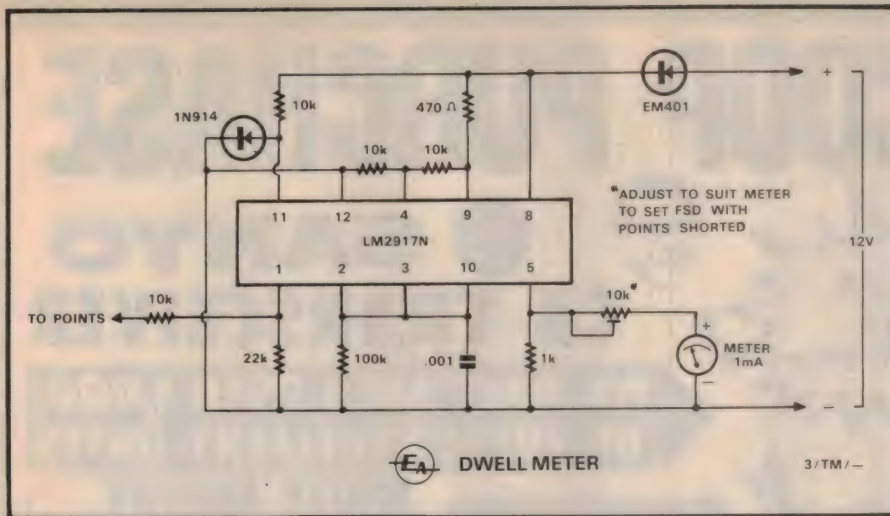
First, dwell affects ignition timing (although the converse is not true) and before carrying out timing adjustments it is necessary to set the dwell to the figure specified for the engine. On Holden 3300cc 6-cylinder engines, for example, this figure is given as 30-35 degrees. If the measured dwell is less than the specified figure the points gap must be decreased. If the reading is too high, the gap must be increased.

Another reason is that too small a dwell angle will result in the coil not reaching magnetic saturation at high rpm, with a consequent poor ignition through loss of spark energy.

To explain further, in the ignition system the spark for ignition is generated when the distributor points, which are in the coil primary circuit, are opened and the magnetic field in the coil collapses. This collapse is quite rapid and causes a high induced voltage in the secondary of the coil, firing the plug.



Our new dwell meter is suitable for 4-, 6-, or 8-cylinder cars. See text regarding the meter calibrations.



To prepare for the next spark, the distributor points must close and let the magnetic field build up again in the coil. This build-up of the magnetic field is not instantaneous, and if the distributor points do not remain closed for long enough it will not have time to build up to its maximum level. The result will be a low secondary voltage and a weak spark.

This phenomenon is particularly noticeable at high speed, and can cause misfiring. It can also make the engine harder to start, particularly in cold weather. For these reasons, it is necessary to allow the points to remain closed for as long as possible.

On the other hand, too large a dwell angle will produce sluggish opening, plus excessive arcing and pitting of the points at low engine speeds. It is also possible that the coil will not have sufficient time to discharge, again resulting in a weak spark and misfiring at high rpm.

A dwell meter is useful for diagnosing engine faults too. A change in dwell angle reading or a wavering of the meter pointer can mean one or a combination of several faults. A fluttering pointer at high engine speeds can indicate points bounce. Increased tension on the moveable-point spring can correct this fault. If the meter pointer wavers, the distributor cam shaft could be wobbling due to worn bearings, or the cam could be worn.

Let's now take a look at the circuit of our new dwell meter.

Heart of the circuit is a National Semiconductor LM2917N IC supplied in a 14-pin dual-in-line package (DIP). This is described by National Semiconductor as a monolithic frequency to voltage (F/V) converter with a high gain op amp/comparator. The op amp/comparator is fully compatible with the F/V converter and has a floating transistor (collector and emitter uncommitted) as its output.

Other features of the chip include an on-chip zener regulator circuit and the ability to source or sink output currents of up to 50ma. Op-amp inputs are

uncommitted and operating voltage is 6-28V DC.

Although the internal circuitry of the chip is relatively complex, the basic principle of operation of the circuit is relatively straightforward. The external pulsating DC signal derived from the points is applied to a differential amplifier driving a positive feedback flip-flop circuit. The flip-flop in turn controls a charge pump which charges or discharges an external .001uF capacitor between two voltage levels.

Since the capacitor's value is fixed and the supply rail constant, the pump current is directly proportional to the input frequency. The differential amplifier, flip-flop and charge pump thus constitute a basic F/V converter.

The output from the F/V converter section is coupled into the inverting input

of an operational amplifier, wired here as a comparator with its non-inverting input biased at approximately half the supply voltage. This in turn controls the output transistor, turning it on and off as the output from the comparator swings high (points closed) and low (points open) respectively.

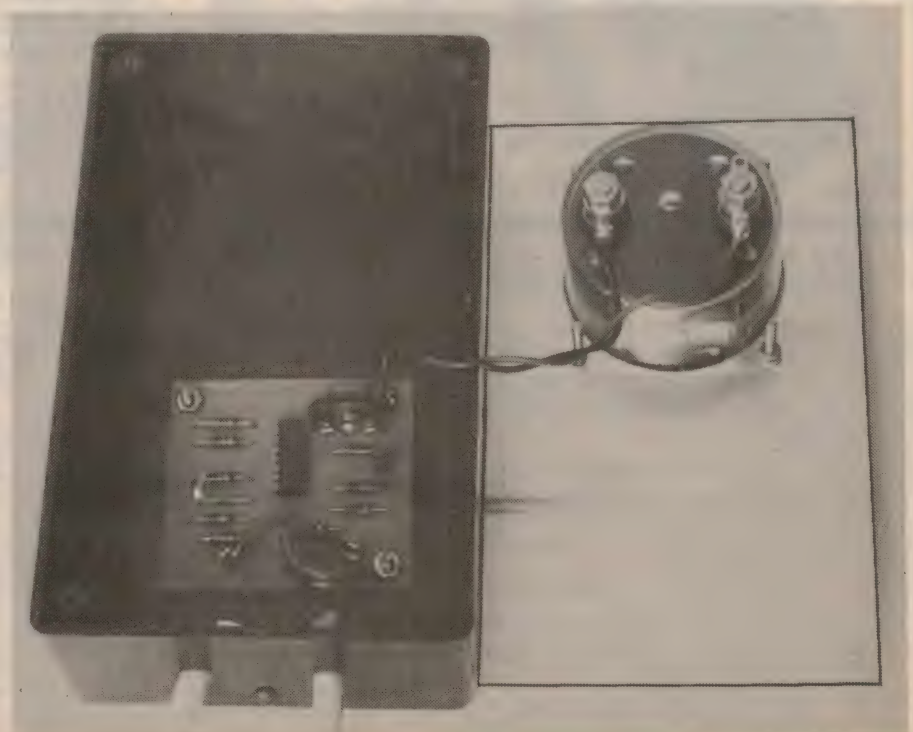
The output is taken from the emitter (pin 5) and applied to the meter through a 10k preset potentiometer. The pot. is adjusted to give a full-scale meter reading with the points shorted. Thus when the ignition points are open the meter reads zero and when the ignition points are closed the meter reads full-scale.

In practice, the ignition points are closed for only part of the time, so the meter will read only the average time they are closed. For example, if the closed and open times are equal, and if the pulses are of sufficiently high frequency, the meter will be deflected one-half of full-scale. Again, if the points have been set with a high dwell angle the average reading will be well up the scale. The reverse applies if the points have been set with a small dwell angle.

We assembled the circuit on a small PC board measuring 56 x 60mm, code 77d7. An overlay diagram showing the placement of components on the board accompanies this article. PC stakes were used to facilitate the five external connections to the board.

The diode in the positive supply line is a precautionary measure to protect the unit in the event of reverse polarity connection to the battery. It may be replaced

Below: inside the completed dwell meter. There is room to include the tach circuit from October '75, if you wish.



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Dwell Meter

on the board by a wire link if you feel it unnecessary, although we consider it to be cheap insurance.

A small plastic case with a light gauge aluminium lid houses the prototype dwell meter. Measuring 150 x 90 x 50mm, these plastic "zippy" boxes are available at low cost from a number of suppliers, including Dick Smith Electronics Pty Ltd.

Many readers will no doubt have a suitable chassis or case which could be used. If the chassis is made of metal it should be connected to the battery supply line which is normally connected to the vehicle chassis.

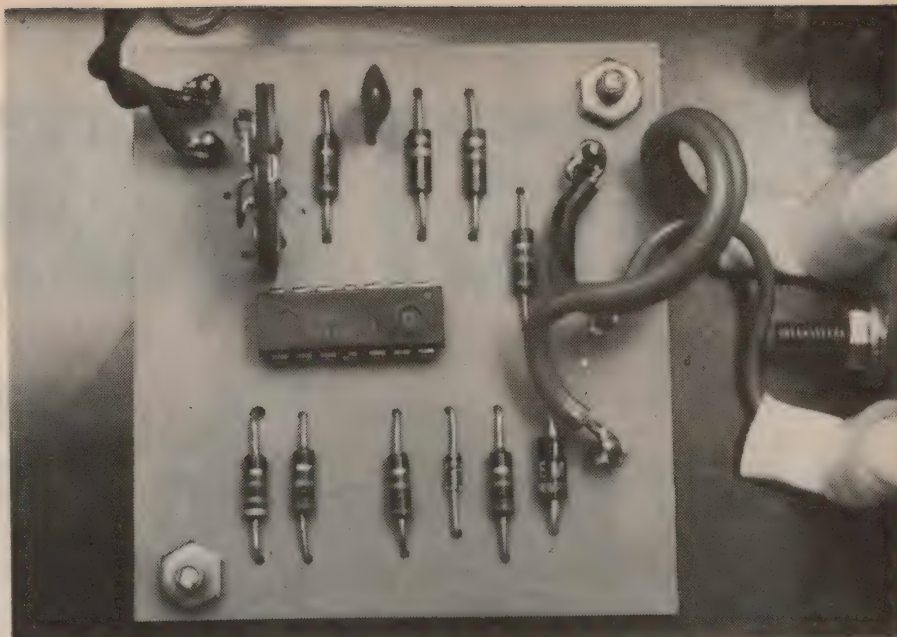
This latter measure prevents hash picked up by the metal chassis of the dwell meter from causing erratic and erroneous readings. In some cases it may also be necessary to fit a 0.1uF bypass capacitor across the supply. Note that a small amount of needle flutter is normal at low idling speeds. If this is considered excessive a low value electrolytic capacitor may be added across the meter terminals.

One metre of two-core flex fitted with large alligator clips was used to make connections to the car battery, while a slightly shorter length of hookup wire fitted with an appropriate clip was used to make the connection to the points. These leads are entered through one side of the plastic case and should be securely clamped as shown in the photograph.

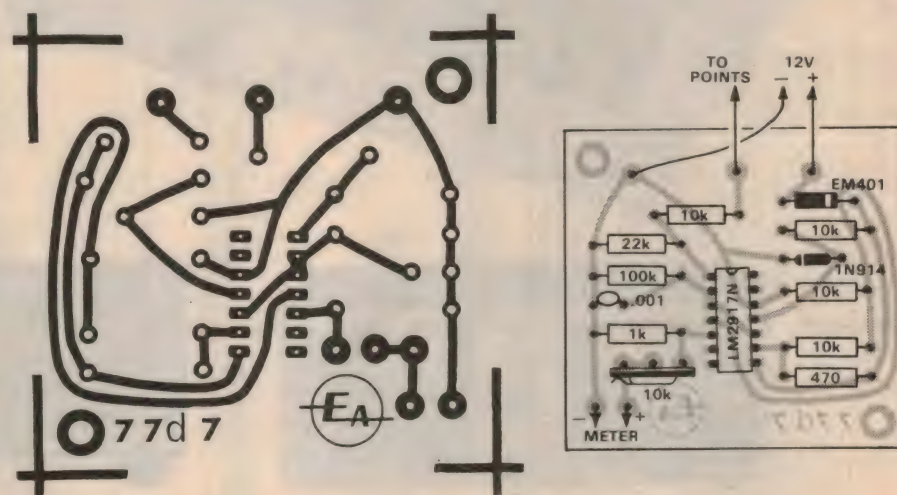
All that remains after assembly is the calibration procedure, which is fortunately quite straightforward. First mark the meter with a linear scale from 0-45° if have an 8-cylinder car, from 0-60° for a 6-cylinder car, and from 0-90° for a 4-cylinder car. Now connect the unit to the vehicle's battery, short the points lead the ground, and adjust the preset pot, so that the meter reads full scale. (Note: it is also normal for the meter to read full scale with the points lead open circuit).

An alternative calibration method is to calibrate the meter from 0-60° and replace the preset pot. with a front panel "dwell calibrate" potentiometer. The dwell calibrate pot. is then adjusted so that the meter reads 60° (full scale) for 6-cylinder cars (points shorted) and 45° when used on 8-cylinder and 4-cylinder cars. Readings are then doubled for 4-cylinder cars.

Other calibration options are also available, and we leave it to readers to make up their own minds. For example, owners of 4-cylinder vehicles could well leave the meter calibrations as they are, simply adjusting the preset pot. so that the meter reads 0.9 or 90°. Again, the meter calibrations may be left as they are, the meter set to read full-scale, and a sui-



Above: a close up view of the assembled PC board. Below left is an actual size reproduction of the PC pattern, while at left is the component overlay diagram.



PARTS LIST

1 case, 150 x 90 x 50mm
1 PC board, 56 x 60 mm, code 77d7
1 LM2917N integrated circuit
1 1mA FSD meter movement
1 1N914 silicon diode
1 EM401 silicon diode
1 .001uF metallised polyester capacitor
1 metre of two core cable
3 alligator clips as required
Solder, hookup wire, machine screws and nuts

RESISTORS

(½ or ¼W, 10% tolerance)
1 x 470 ohms, 1 x 1k, 4 x 10k, 1 x 22k,
1 x 100k
1 x 10k preset potentiometer

NOTE: Resistor wattage ratings and capacitor voltage ratings are those used in our prototype. Components with higher ratings may generally be used provided they are physically compatible.

table relating calibrations to actual dwell values made up.

There is one further option available to the constructor, and that is to fit the tachometer circuit described in the October 1975 issue (File No. 3/TM/11) into the same

case. This tachometer was based on the Philips SAK140 IC, was low in cost and easy to build. The author can certainly testify to its value, and that together the two instruments make a very useful tune-up aid.

CB TEST EQUIPMENT



CB Servicemaster

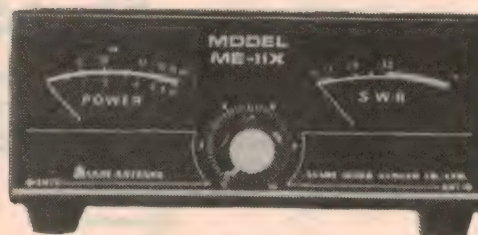
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- Only one hookup required for all tests
- Eliminates need for special equipment



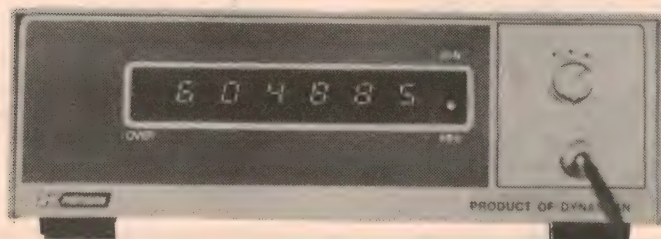
MODEL 2040 PLL CB SIGNAL GENERATOR

- Designed for use with all class D CB transceivers . . . AM and SSB.
- Covers all 23 channels plus provision for additional channels for future expansion.
- ± 5 parts per million (.0005%) accuracy or better.



MODEL ME-11X SWR & POWER METER

- | | |
|------------------------|---------------------|
| Measuring method | Directional Coupler |
| Maximum handling power | 1 kW |
| SWR indication | 1:1 ~ 3:1 |
| Frequency Range | 3.5-150 MHz |
| Circuit Impedance | 50 ohm |

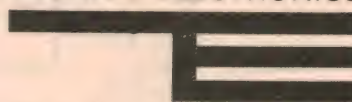


MODEL 1801 40 MHz AUTORANGING COUNTER

- Automatic ranging 20 Hz-40 MHz guaranteed.
- 1 Hz resolution.
- Six-digit solid-state readout with discrete reliable TTL logic.

For general and specific information:

TECNICO ELECTRONICS



Premier Street, Marrickville,
N.S.W. 2204. Tel. 55 0411.

2 High Street, Northcote,
Vic. 3070. Tel. 489 9322.

THE 27MHz SCENE

EQUIPMENT FOR SERVICEMEN—CB STYLE!

While a fair amount has been published about 27MHz transceivers, and about the simple gadgetry and test equipment which a private operator might own, not much has been said about the specialised equipment which would be needed by anyone who proposed to become involved seriously in the servicing of 27MHz transceivers.

by NEVILLE WILLIAMS

If present trends continue, and follow those already established in the United States, the servicing of 27MHz transceivers may well become an important alternative source of income for those who have hitherto relied on TV service.

When colour television was announced for Australia, it was freely tipped that it would make tremendous demands on local TV servicemen, both in regard to the new technology involved and the number of calls which would need to be handled. After all, with three or four times as many components to go wrong, it seemed inevitable that there would be three or four times as many breakdowns.

With a few models, the prediction looked like coming true but, once the teething troubles were eliminated, the frequency of calls dropped dramatically such that the failure rate has fallen, in some cases, to as low as 0.3 per set per year! As a result, a lot of TV servicemen are finding their skills and their premises under-utilised.

Diversification into hifi, public address and industrial servicing are possible options, but a boom into 27MHz trans-

ceiver usage would provide yet another.

At the time of writing, the Australian Government has still not spelled out its policy in regard to the 27MHz band and it remains very much a zone of confusion in the spectrum, currently populated by a fair number of licensed amateur operators, a much larger number of "CB" type operators on air illegally, plus a sprinkling of industrial communicators, paging systems and electronic heating equipment.

Check-by-jowl with this part of the spectrum (26.965MHz to 27.255MHz) are channels allocated for mobile marine, surf life saving clubs and bushfire brigades, all of whom could provide additional custom for the enterprising repairman.

If a segment of the band is made available for legal CB (Citizens Band) operation, the amount of equipment in use will rise dramatically and, while modern CB transceivers are very reliable for the same basic reasons as are modern TV sets, there will inevitably be a certain proportion of equipment failures and a certain amount of repair work to be done, as a result.

But here a rather special problem may arise:

If CB operation is legalised, it is almost certain that it will be limited to type-approved transceivers, possibly with some dispensation for crystal locked equipment already in the hands of the public. This would mean that dealers could only import (or manufacture) and sell models which had been specifically tested and approved by the P&T Radio Branch. No internal modification or adjustment would be permitted by the user and there may also be some limitation on those authorised to repair them.

While it is unlikely that the regulations would be too stringent in this regard, anyone who aspires to repair CB transceivers efficiently and to within specifications will certainly need a basic understanding of transmitter technology, plus the appropriate kind of test equipment.

What could be involved is spelled out in literature recently to hand from the Dynascan Corporation, makers of B&K-Precision test equipment. They are represented in Australia by Tecnico Electronics of Premier St, Marrickville, NSW 2204, Tel (02) 55 0411. (In Victoria: 2 High St, Northcote 3070. Tel (03) 489 9322.)

B&K list the following items of test equipment as being desirable or necessary for checking a typical 27MHz CB-style transceiver. Some of the items would already be available in a well equipped service shop; others could be organised without too much trouble. Still others would have to be specially provided.

For testing the receiver:

SIGNAL GENERATOR: This must provide a stable signal over the frequency band involved. It must have very low leakage and have an output meaningfully metered down to 1 μ V or below to give any useful confirmation of sensitivity. Traditional 0.3 to 30MHz laboratory signal generators are hard pressed to meet these requirements. In addition, dial calibrations cannot be relied upon to differentiate between CB channels or to indicate receiver frequency error.

AUDIO DUMMY LOAD: Adjustable for 4, 8 and 16 ohms, at 5% or better. Must be capable of dissipating not less than 5 watts continuous. This could be contrived by any electronic handyman given a suitable box, switch and resistors.

AUDIO WATTMETER: May include a dummy load. Should ideally be capable



The B&K-Precision 2040 signal generator is intended expressly for servicing 27MHz CB-style transceivers. It provides output on 50 channels each 10kHz apart to a frequency accuracy of .0005%, with a offset facility of ± 5 kHz. Leakage is very low and the attenuator is calibrated down to 0.3 μ V. For IF alignment, there is an in-built crystal controlled oscillator.

THE 27MHz SCENE

of reading directly in watts and with ranges to 0.1, 1.0 and 10. The same information can be derived by reading the RMS volts across a separate dummy load, at an acceptable maximum distortion level and using the formula:

$$W = E^2/R$$

AUDIO TONE GENERATOR: 1kHz source with less than 1% distortion and of adjustable amplitude suitable for feeding into the receiver audio channel. Most bench type audio generators will meet this requirement.

AUDIO DISTORTION METER: Necessary if receiver output power is to be verified against the published rating, for a stated level of distortion. Alternatively, the overload point can be judged visually with the aid of an oscilloscope.

CATHODE-RAY OSCILLOSCOPE: Almost any test bench oscilloscope will permit adequate inspection of audio waveforms. However, if it is to display the RF envelope from the transmitter, it will need to cope with 27 MHz, either via the amplifiers or fed direct to the deflection plates.

DC POWER SUPPLY: Must be adequately smoothed and well regulated with a maximum current capacity of about 2.5 amps, higher if practicable. Output voltage should be in the region 13.5 to 13.8 at any current up to maximum rated. Voltage adjustable through a limited range is an advantage on occasions.

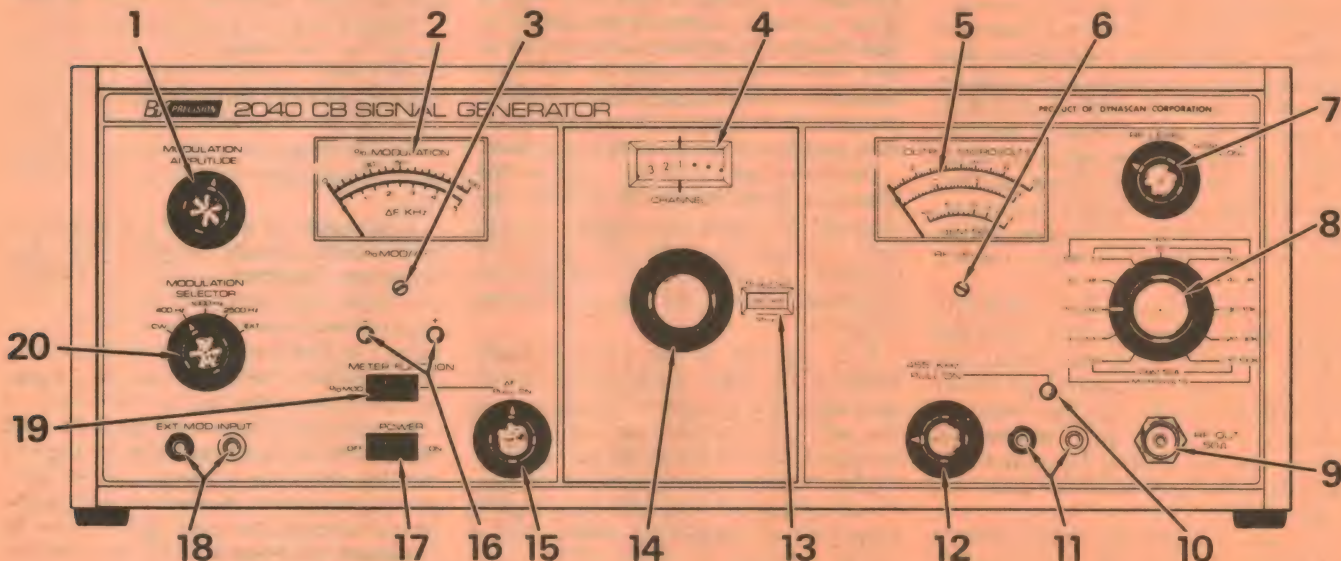
The same power supply would serve for the transmit function but, to test the

transmitter completely further instrumentation would be required:

RF DUMMY LOAD: 50 ohms, not less than 5 watts dissipation, preferably somewhat higher. Construction of an RF dummy load was detailed in our April issue, page 31. (Note that a dummy load is sometimes provided as an integral part of a power meter or VSWR meter).

RF POWER METER: Typically calibrated 0-10W. Reasonable accuracy is required (5% or better) if the readings are to be meaningful in terms of the transceiver published ratings.

VSWR METER: Often included as a facility with RF power meters. Constructional details for a standing wave ratio meter were published in our April issue, page 35.



SPECIALLY DESIGNED FOR CB:

1. **MODULATION AMPLITUDE Control.** Adjusts percentage of modulation for RF output signal (modulation of 455kHz output signal is fixed at approximately 30%).
2. **% MOD/ΔF Meter.** Top scale reads percentage of modulation for RF output signal. Bottom scale reads amount of frequency offset from the selected channel frequency for ΔF mode.
3. **Zero Adjust for Meter (2).**
4. **CHANNEL Indicator.** Displays the CB channel number of the RF output.
5. **RF LEVEL Meter.** Provides fine reading of RF output level in microvolts and dBm.
6. **Zero Adjust for Meter (5).**
7. **RF LEVEL/NOISE GEN Control.** Rotation is vernier adjustment of RF output level. Pull control to turn on noise generator; noise generator level is not adjustable.
8. **RF Attenuator.** Selection of RF output level in 10 dB steps from -10 dBm to -110 dBm. Steps are also calibrated in microvolts from 100K down to 1 microvolt.
9. **RF OUT 50 ohm Jack.** RF output jack, 50 ohms impedance.
10. **455kHz Indicator.** Lights when 455kHz generator is on.
11. **455kHz Output Jacks.**
12. **455kHz Control.** Pull to turn on crystal-controlled 455kHz generator. Rotation adjusts output level; level is not metered.
13. **FREQUENCY Indicator.** Displays selected channel frequency of RF output signal in MHz.
14. **CHANNEL Selector.** Selects CB channel (frequency) of RF output (selects reference frequency when ΔF is on).
15. **ΔF Control.** Pull to select ΔF RF output, which is tunable ±5 kHz above and below the selected channel frequency. Rotation of control provides vernier adjustment of ΔF of output frequency.
16. **(-) Green and (+) Amber Indicators.** The green (-) indicator lights when ΔF is below the selected channel frequency, displayed on frequency indicator (13). Amber (+) indicator lights when ΔF is above the selected channel frequency. One of the indicators is always lighted when ΔF is on. When either indicator flashes on and off, ΔF is tuned almost precisely to the selected channel frequency.
17. **POWER Switch.** Turns signal generator ON and OFF. Meters (2) and (5) are illuminated when power is on.
18. **EXT MOD INPUT Jacks.** Input jacks for external modulation.
19. **METER FUNCTION Switch.** Selects function of meter (2). % MOD position connects meter to read percentage of modulation. ΔF position connects meter to read amount of frequency offset from selected channel frequency.

THE 27MHz SCENE

TWO-TONE AUDIO GENERATOR:

Required to modulate an SSB transmitter. A handy facility is to have the tones available through a miniature loud-speaker with padded surround, similar to some headphones, so that tones can be fed acoustically to the transceiver microphone, both as a convenience, and to indicate relative microphone sensitivity and modulator gain.

DIGITAL FREQUENCY COUNTER: Must have adequate sensitivity over the 27MHz range and have a display accuracy of 100Hz or better. Necessary to check the accuracy of transmitter output against the official channel frequency, both in absolute terms and in the presence of suspected drift.

While this adds up to a rather forbidding list, it remains for the individual serviceman to determine how deeply he is prepared to get involved. In many cases, repair will simply mean finding a faulty connection or a faulty component.

In other cases, the fault situation and its repair may upset basic adjustment of the transceiver, in which case more adequate instrumentation may be necessary.

In their approach to this situation, B&K Precision have come up with a group of instruments, two of which are notably specialised: the 2040 CB Signal Generator and the 1040 CB ServiceMaster.

The 2040 signal generator includes a precision crystal-controlled phase locked loop system which provides output on 50 distinct channels, including the original U.S. class-D 23-channel allocations, with a frequency accuracy and stability of better than 0.0005%. A vernier control provides for ± 5 kHz, giving virtually continuous frequency coverage across the particular portion of the spectrum.

The generator is double shielded and its output is calibrated from 0.3uV to 100mV.

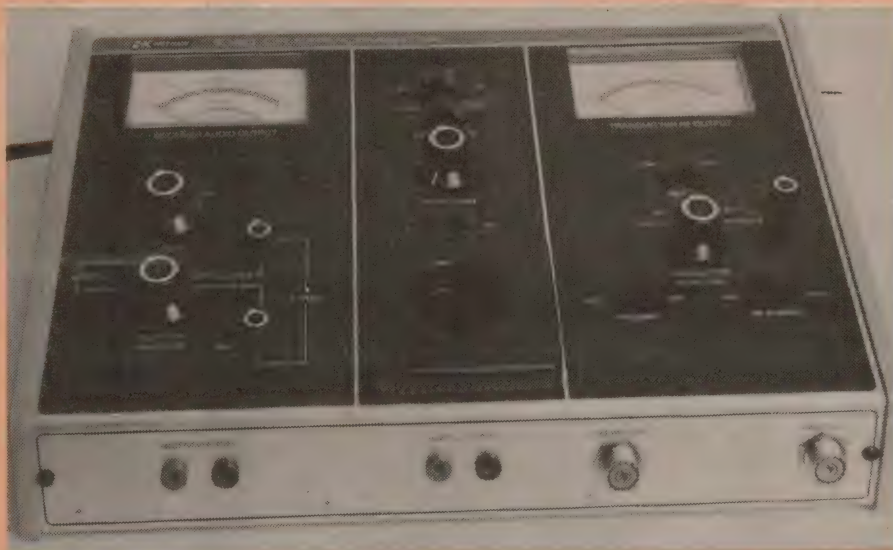
The signal is available unmodulated, or amplitude modulated by 400Hz, 1000Hz and 2500Hz, adjustable to 100%. The offset facility also allows the generator to simulate single tone SSB modulation.

Built into the 2040 is a special impulse noise generator which allows proper checking of receiver noise blanking.

For IF channel adjustment, a separate crystal locked 455kHz oscillator is provided.

Significantly the generator output circuit is specially protected against damage in the event of an operator pressing the transceiver transmit button and feeding its output back into the generator.

Companion instrument to the signal generator is the B&K-Precision 1040 CB



The B&K-Precision 1040 CB Servicemaster. The panel on the left has predominantly to do with testing the receiver's audio system, measuring power out and distortion. On the right is the transmitter test panel; RF power output and SWR. The audio oscillator in the centre provides single tone and two-tone output, as an electrical and an acoustic signal.

ServiceMaster, also pictured. Specially designed for the purpose, the ServiceMaster can be interconnected to a 27MHz transceiver in a standardised way and will provide test facilities which might otherwise involve a whole array of separate items, as listed earlier.

It provides an audio tone source at 1000Hz with less than 1% distortion, and at adjustable amplitude, for testing either the receiver audio system, or modulating the transmitter. A two-tone test signal is also available at 500 and 2400Hz for SSB modulation testing. The tones are available either by way of a socket and cable connection, or through a padded loud-speaker outlet on the 1040 panel, which can be used to drive a transceiver microphone acoustically.

An audio wattmeter facility is incorporated, which has selectable audio dummy loads of 4, 8 and 16 ohms at 10 watts dissipation. The scale is calibrated directly in milliwatts (0-100) or in watts 0-1.0 and 0-10. Companion dB scales are also provided and the frequency response is quoted as with in 0.5dB from 30Hz to 15kHz.

For power output readings to be meaningful, the distortion level must be known and the 1040 has an in-built facility which reads distortion (with 1kHz

input) directly in terms of 0-30. A connectoscope automatically feeds the receiver output to the CRO input when receiver tests are being performed.

For transmitter tests the 1040 has an in-built 50-ohm load rated at 50W continuous (100W intermittent) and the RF power across this load can be measured directly on a wattmeter scale calibrated 0-10, 0-50 and 0-100 watts. Metering can be in terms of forward or reverse, average or peak. During "transmit" tests, the CRO output socket receives the RF envelope, allowing it to be inspected on an external instrument.

By connecting a resonant antenna to the "external load" connector on the 1040, SWR (Standing Wave Ratio) can be measured within the range 1:1 and 5:1.

B&K-Precision have so designed the CB ServiceMaster that it can be interconnected directly with their signal generator, an external oscilloscope, and a transceiver under test. Thereafter, all tests can be performed in sequence without changing the test set-up.

Manuals available for the 1040 (60pp) and for the 2040 (40pp) detail approved procedures for the sake of those who are not as familiar as they might be with transceiver testing.

Other items in the B&K-Precision range of 27MHz test equipment listed but not provided for our inspection include:

Model 1801 Digital Frequency Counter.

Model 1403A CR oscilloscope

Model 1640 regulated power supply.

Further details of all these items can be obtained from Tecnico Electronics at the addresses given earlier in the article.

ROYCE TRANSCEIVERS:

On page 43 of our April issue, we indicated that Unitrex of Australia Pty Ltd would be distributing Royce transceivers. Unitrex have advised us that they will not be proceeding with this arrangement.

New low cost digital logic trainer

We're very proud of this exciting new digital logic trainer. It not only outperforms our previous designs by far, but is lower in cost and much easier to build. Our tip is that it will become the new standard for teaching digital logic concepts in schools, colleges, industry and at home.

by DAVID EDWARDS

One of our most successful projects in recent years has been the Digital Logic Trainer described in the March and April 1973 issues. This unit was based on TTL integrated circuits, and enabled simple logic concepts to be demonstrated in an easily understood form.

Unfortunately, due to the rising costs of some of the hardware required for this project, such as the insulated chassis feedthroughs and the diecast box, the unit has become quite costly to build in recent months. The new trainer described in this article is the end result of a conscious effort to reduce costs, simplify construction and improve performance.

Our first efforts were directed to reducing the costs of the interconnections. In 1973, 250 insulated feedthroughs and 50 clip leads to suit cost \$15.50. The current price of these components

(obtained from the new DSE catalogue) is \$31.75.

The scheme we have evolved for the new trainer dispenses with the insulated feedthroughs, and replaces them with plain PCB pins, mounted directly onto a PC board. The estimated cost at the time of writing for 250 of these pins is about \$5.00.

A further significant saving can be made by not using the pre-assembled clip leads, but by having the individual constructor assemble his own leads from clips and hookup wire. The estimated cost for 50 leads made up in this manner is about \$6.00, giving a total price for the leads and pins of about \$11.00.

Having achieved a cost reduction in this area, we then turned our attention to the general construction principles. Having decided to use a PCB as a front panel, it became logical to mount the ICs and other components directly on that PCB, thus eliminating a separate front panel and the need to have a lot of wiring between the two.

The required labels and lettering for the front of the trainer can be applied by a silk screening process, in exactly the same way as component overlays are applied to the top of a board. In this case, however, the board would first be screened white all over, and the labels and letters then screened on in black.

Our next decision was to implement the logic elements required in CMOS rather than TTL. The main advantage of this is that it allows the unit to be battery powered rather than from the mains. Not only does this reduce the cost, it also makes the unit more portable, and safer for use with students.

At this stage, it seems appropriate to describe in some detail the end result of all these decisions. The Digital Logic Trainer Mark III is mounted in either a wooden or metal case, about 60mm

deep, and the approximate size of this page.

The front panel consists of a large printed circuit board, measuring 282 x 226mm, and coded 77dlt7. It is silk screened with black letters and diagrams on a white background.

Two hundred and seventy nine circuit board pins are fitted to it, along with five LEDs, seven switches and a potentiometer.

On the underside of the board are mounted ten ICs, one transistor, and a number of resistors and capacitors. The only components not mounted directly

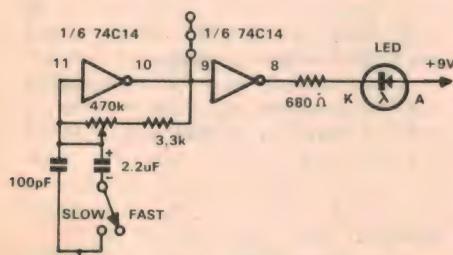
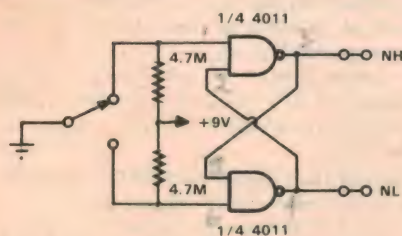


FIG. 1 CLOCK CIRCUIT (ONE REQUIRED)



DEBOUNCED PULSE GENERATOR (TWO REQUIRED) FIG. 2

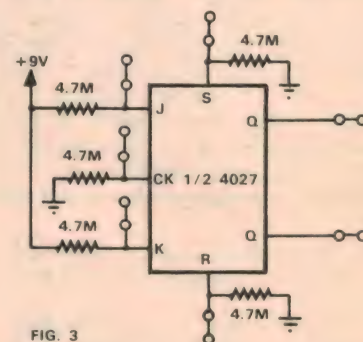
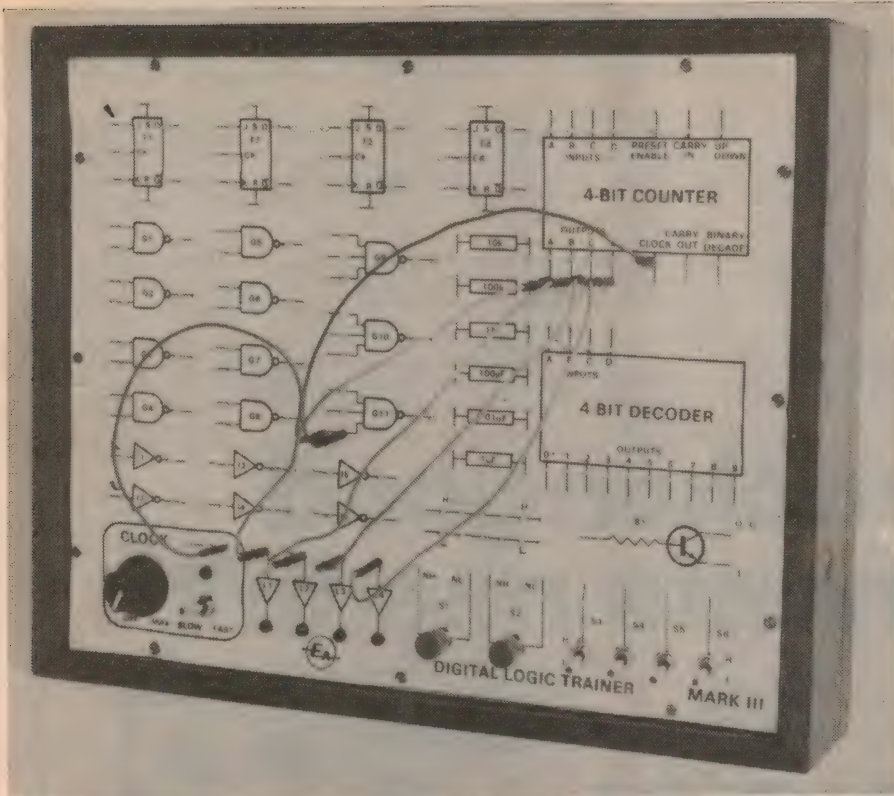


FIG. 3

J-K FLIP FLOP (FOUR REQUIRED)

to the board are the batteries and their holder. No links are required, apart from those connecting to the switches and other similar components whose terminals are not directly adjacent to the board.

We mounted the prototype in a wooden case, which we rebated at the top so that the PCB pins did not stick out above the edges of the box. The PCB is held in position with 12 screws around the edges. Provision has also been made for an optional extra support in the centre of the board, although we felt that this was not required on the prototype.



Above is the completed trainer with some of the interconnecting leads. It can be used to demonstrate virtually all of the basic concepts of digital logic.

Alternatively, an aluminium case could be used. We have prepared a metalwork drawing of a suitable case, and dyeline copies of this will be available through our Information Service for the usual fee. Copies are also being distributed to metalwork manufacturers, and so cases should be available from your usual component supplier in the near future.

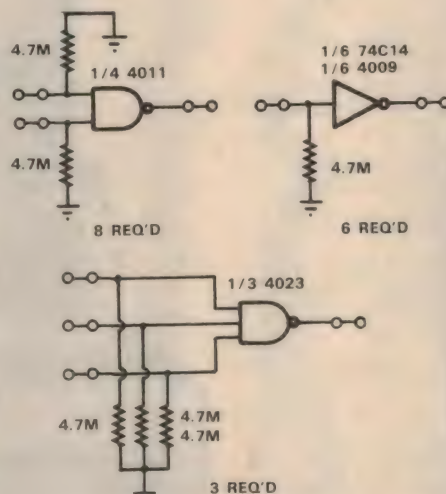
Turning now to the circuit diagrams, we can discuss the various logic elements provided, and how they have been implemented.

Fig. 1 shows the clock generator. Two clock rates are provided, each adjustable over a range of approximately 140:1. The highest frequency obtainable is about 1MHz, while the lowest is about 0.5Hz.

The clock has been implemented with a Schmitt trigger, and requires only two resistors and two capacitors. A second Schmitt trigger is used as a buffer to drive a LED. This serves to give a visible indication of the slower clock rates, and also serves as a pilot light for the trainer as a whole.

The rate control is a switch-pot, with the switch functioning as a power switch for the batteries.

Fig. 2 shows the manual pulse generator circuitry. Two of these are required, and they are implemented with R-S flipflops formed from dual input gates. The switch required is a momentary action pushbutton type. A 4011 type chip is used to supply the four gates required.



NAND GATES AND INVERTERS FIG. 4

Fig. 3 gives the circuit details of one of the four J-K flipflops provided. These are implemented with 4027 dual flipflop chips. The reset, set and clock inputs are all active high types, so they are tied low with 4.7M resistors.

The J and K inputs are tied high, as this is the most common way in which they are used. This means that, to implement a four bit counter, it is only necessary to connect the output of the first flipflop to the clock input of the second, and so on. The J, K, set and reset inputs can be left unconnected.

PARTS LIST

SEMICONDUCTORS

- 1 4009 or 4449 hex inverter
- 3 4011 quad gates
- 1 4023 triple three-input gate
- 2 4027 dual J-K flipflops
- 1 4028 BCD to decimal decoder
- 1 4029 presettable up/down 4 stage counter
- 1 74C14, CD 40106 or MCM 14584 hex Schmitt trigger
- 1 BC548 or similar NPN transistor
- 5 red light emitting diodes

CAPACITORS

- 1 100uF 10VW electrolytic
- 1 2.2uF 35VW tantalum electrolytic
- 1 1uF polyester
- 1 0.01uF polyester
- 2 100pF polystyrene or ceramic

RESISTORS (all 1/4W)

- 5 680 ohm, 1 3.3k, 3 10k, 1 100k, 1 1M, 73 4.7M (see text)
- 1 470k linear switch-pot

SWITCHES

- 5 SPDT miniature toggle switches
- 2 DPDT momentary action pushbutton switches

MISCELLANEOUS

- 1 printed circuit board, coded 77dlt7, 282 x 226mm
- 279 circuit board pins (see text)
- 1 knob
- 6AA cells, holder and clip to suit
- Bracket to hold battery container, fashioned from scrap aluminium
- 1 set of clips to suit PCB pins
- 1 IC lead bending tool, see Fig. 8
- 1 case, wooden or metallic as required (see text)
- Hookup wire, tinned copper wire, solder, insulating tape

NOTE: Resistor wattage ratings and capacitor voltage ratings are those used for our prototype. Components with high ratings may generally be used provided they are physically compatible.

Eight dual-input and three three-input gates are provided, using two 4011 and 4023 chips. All inputs to these gates are tied low. Fig. 4 gives the circuit details.

Also shown in Fig. 4 is the circuit of the six inverters provided. Two of these are implemented using Schmitt triggers, while the remaining four are implemented with normal inverters. All inverter inputs are tied low.

Four LED drivers are provided, along with four LEDs. Two of the drivers make use of Schmitt triggers, while two are implemented using inverters. Current

Just check the Specs of these few!

AG203A CR Oscillator goes from 10Hz to 1MHz with a frequency response of ± 0.5 db. Under 0.1% distortion, output is 7V rms sine 10V p-p square wave. Built in 6 step attenuator.

CO1303D Oscilloscope Popular with hobbyists and professionals. Bandwidth to 5MHz with 10mV/div sensitivity. E series companion to the AG202A, the SG402 RF generator and VT108 VOM.

PR654 Lab Power Supply Offers constant voltage or current modes with remote sensing and programming. Output variable 0-35V and 0-3A. Ripple better than 1.5 mV p-p. Dual meters and very solid construction. Other Trio supplies available 0-18V and 0-1.5A.

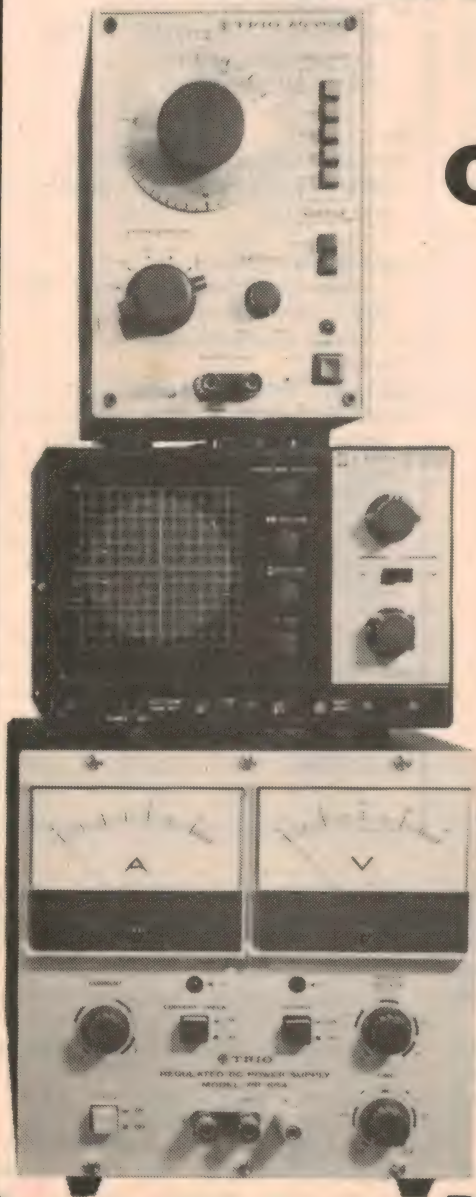
DL703 Digital Multimeter features 3½ digit display covering Vdc to 1000V, Vac to 350V, DCA to 200mA and ohms to 20M. Automatic polarity, overflow display. AC mains powered. Ideal lab instrument.

AG202A CR Oscillator covers 20Hz to 200kHz both sine and square wave outputs. Output voltage 10V rms sine 10V p-p square. One of the very popular 'E' Series instruments which includes the scope alongside an RF generator covering 100kHz to 30MHz and a VOM with built in memory.

FC754 Frequency Counter has a 6 digit display with memory and leading zero blanking. Frequency range 100Hz to 250 MHz with high sensitivity of 50mV rms. Stability better than 1ppm/month.

CS1562 Oscilloscope the greatest 10MHz dual trace scope value! 130 mm CRT, 10mV/div sensitivity, automatic sweep, X-Y operation, 5x magnifier, 35nS rise time sweep times from 1µS to 0.5 s/div plus free x10 probes. (If you need more bandwidth ask about the 15MHz CS1560A).

Trio reckon good instruments needn't be costly



Ask for a Trio Catalogue at leading electronics stores or send stamped self-addressed envelope to Parameters Pty.Ltd. 68 Alexander St., Crows Nest, N.S.W. 2065.



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PM51

Digital Logic Trainer Mark III

limiting resistors are provided for the LEDs, to limit power consumption.

The inputs to the LED drivers are pulled low. This means that the LEDs are normally extinguished, thus conserving battery power when they are not in use.

A single uncommitted buffer has been provided, to enable an output from the trainer to be interfaced to other logic systems (including those using TTL). It consists of a single BC108 type transistor, with an uncommitted collector. Fig. 6 gives the circuit details.

All of the above elements are similar to those found in the previous logic trainer. The two elements about to be described are additions. Fig. 7 gives the circuit details.

The first of these additions is a 4029 presetable binary/decade up/down counter. This chip is basically a four bit counter, which can be programmed to count either up or down, and in binary, BCD or octal code. It has four parallel inputs, which can be loaded into the counter independently of the clock.

Pull up and pull down resistors have been provided to program the 4029 as a 4-bit binary up counter, which can be reset to zero by taking the preset enable input high. The clock input is active high, and thus is held low.

As well as its obvious uses as a counter scaler and frequency divider, it can also

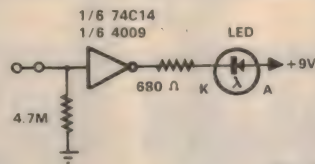


FIG. 5

LED DRIVERS (FOUR REQUIRED)

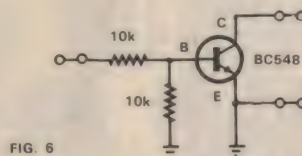


FIG. 6

OUTPUT BUFFER (ONE REQUIRED)

be used as a four bit latch. Frequency division ratio and counting modulus between two and sixteen can be achieved using the preset facilities and suitable output decoding logic, formed from the gates and inverters.

The second addition is a 4028 BCD to decimal decoder. This has four inputs, which are interpreted as a binary code. One of the ten output pins is driven high for each of the ten BCD codes. Codes other than BCD codes (e.g. 1111) produce spurious outputs.

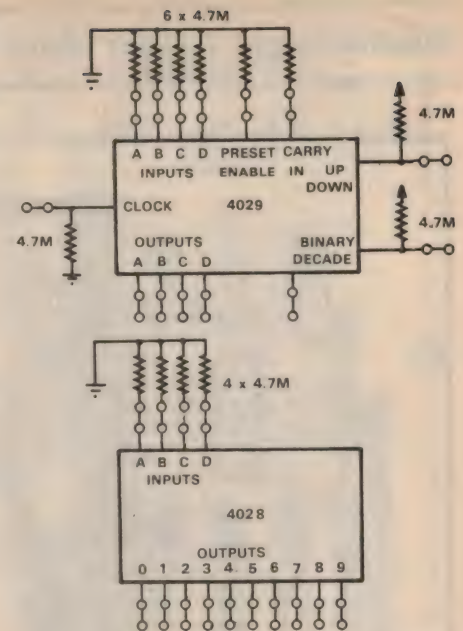


FIG. 7

4-BIT COUNTER AND DECODER

If the D input is left unconnected, the 4028 will act as a one-of-eight or octal decoder. It can also be used in conjunction with the 4029 to form a divide-by-N counter, where N is less than ten.

The remaining feature provided is a selection of resistors and capacitors. Three of each type of component are provided, enabling RC circuits to be formed with time constants ranging from 1µs to 1s in decade steps.

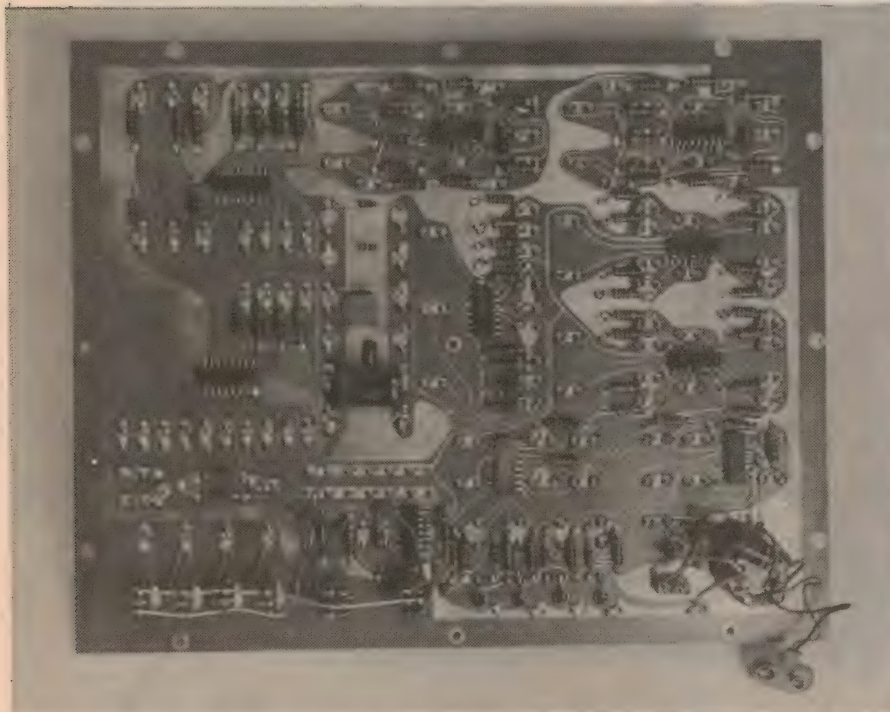
We have specified 4.7M values for the pull up and pull down resistors on the trainer elements but this is not critical. Values anywhere between 4.7M and 10M can be used with success. Lower values can also be used, although they will then significantly alter the effective resistance of the 1M resistor, and will also tend to load down the 100pF capacitor when these are used.

Seven positive and seven negative supply pins are provided, to enable inputs to be set high or low as required. All inputs and outputs are provided with two connection points, allowing them to be "daisy chained" together. The only exception to this is the clock generator, which has three outputs.

The power supply is simply six AA cells in a suitable holder. A 100µF 10VW electrolytic capacitor is wired in parallel with the batteries, to ensure that the logic elements see a low supply impedance.

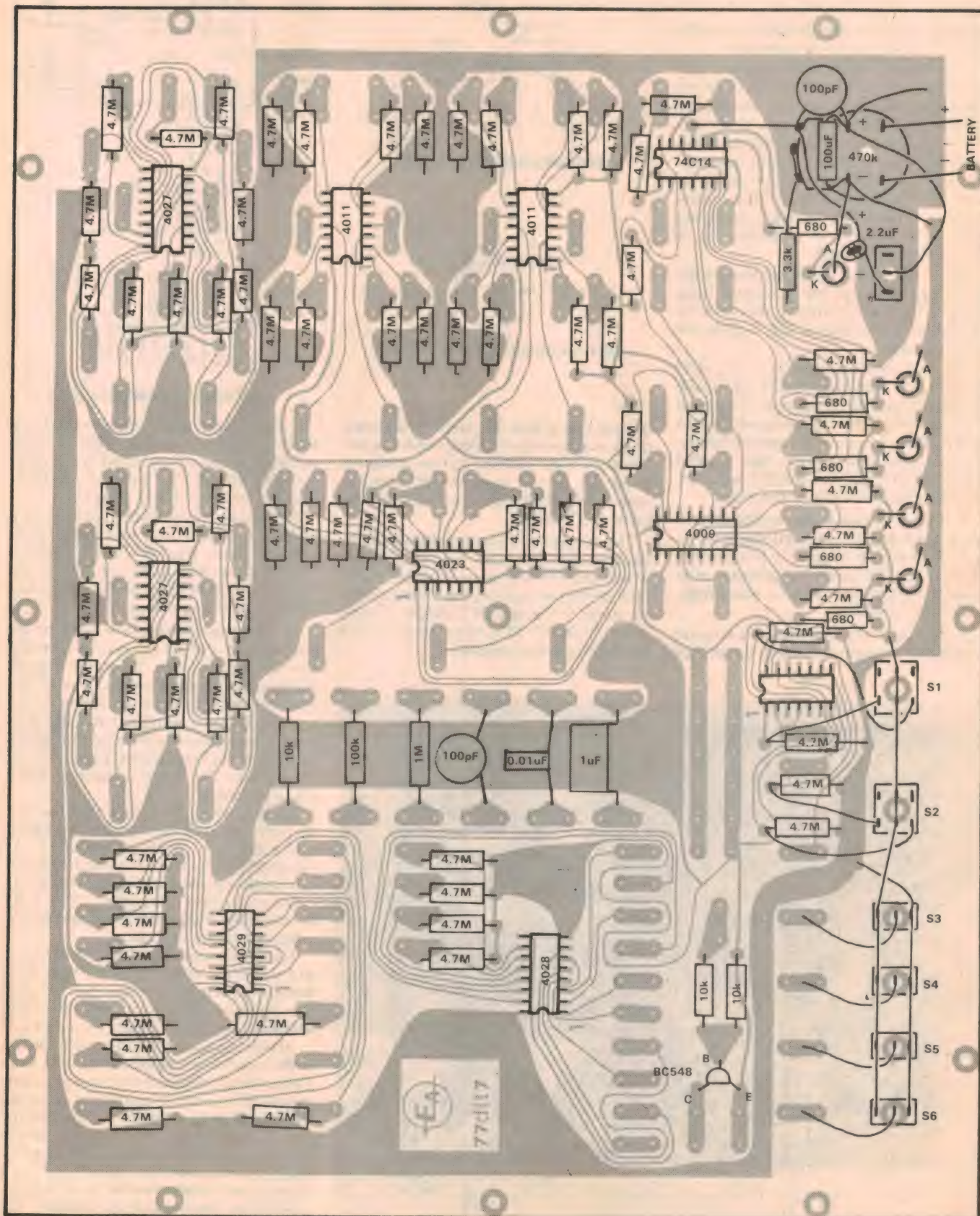
At this stage, a few comments are in order regarding construction of the unit. Firstly, the ICs must be mounted in a non-standard manner, because they are on the copper side of the PCB. Careful scrutiny of the PCB pattern will show that the IC pins are spaced the usual 0.1 inches apart, but that the two rows of pins are 0.4 in apart, rather than the usual 0.3 in.

This has been done to facilitate the mounting of the ICs on the board. Fig. 8 gives details of a small jig which is used to bend the ends of the IC leads into a



A view of the completed PCB assembly. Note that the components have been mounted on the copper side of the board and soldered direct to their respective copper pads.

Digital Logic Trainer Mark III



Follow instructions in the text regarding the order and method of mounting components.

plane parallel with the body of the IC. The IC is inserted upside down into the channel, and the leads then bent outwards.

It will then be found that the IC will fit exactly onto the pattern on the PCB, and can be easily soldered into position. More about this shortly.

The LEDs are intended to be a force fit into their mounting holes, with their leads then bent over and soldered to the copper pads provided. Tinned copper wire, insulated where necessary, is used to make the connections to the switches.

The resistors and capacitors are bent, using long nosed pliers, into a "top hat" shape, and then soldered directly to the board.

Construction is commenced by fitting the PCB pins. These are a force fit into the board. They can be fitted with the aid of pliers, or with a small tool made from a discarded pot. shaft. Drill a hole slightly larger in diameter than the pins into one end of the shaft, keeping the depth less than half the length of the pins.

The switches, controls and LEDs should be fitted next, along with all the associated links. Then bend and fit all the remaining passive components, taking care not to inadvertently short out any of the tracks. Use a soldering iron, with a narrow bit, and a minimum of solder.

The next step is to fit the CMOS ICs. First, tin the power supply pads for all the ICs. These are pins 7 and 14 for the 14 pin devices, and 8 and 16 for the 16 pin devices.

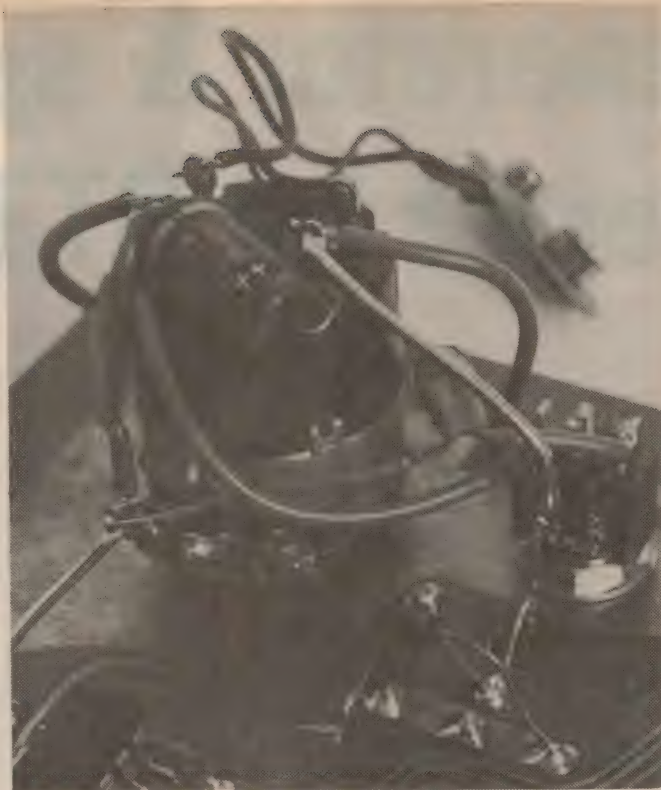
Now earth the barrel of your soldering iron, and the lead bending jig to the earth line of the board. Unwrap a 4011 device, and insert it into the jig. Using a wooden ruler or a small piece of aluminium, carefully bend the leads of the IC, making sure that they are not bent sideways in the process.

Then remove it from the jig, and place it with the correct orientation onto the board. Solder the two supply leads first, checking that all leads are centred on their respective pads. Once you are sure all is OK, solder the remaining leads, using a minimum of solder.

The remaining ICs can then be fitted in a similar manner. When they have all been fitted, carefully check the whole board for solder bridges, misplaced components and similar faults.

That should complete construction, so testing can now commence. With the power switch off, connect up the battery. When the power is turned on, the clock LED should light up immediately. The rate of flashing should vary with the setting of the rate control, and the slow/fast switch. At the higher rate settings, the LED will emit at half brilliance all the time.

The indicator LEDs should only emit when their driver input pin is connected to a high logic level. All gate and inverter outputs should be high, going low only



This close-up view details the wiring associated with the 470k switch-pot and the clock-rate switch. Refer also to the component overlay diagram.

Diagram showing the dimensional details of the IC lead bending jig. The IC is inserted upside down into the channel and the leads bend outwards using a ruler or a small piece of aluminium.

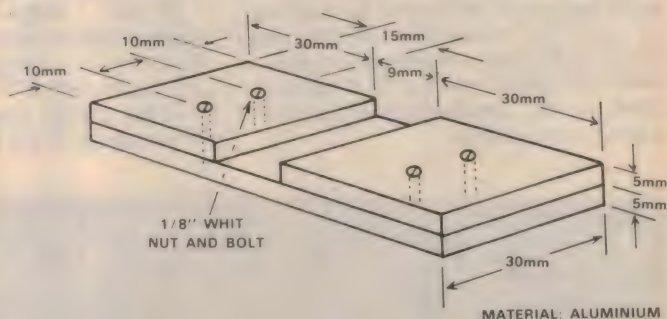


FIG 8

IC LEAD BENDING JIG

when the required input conditions are met.

The flipflops can be checked by connecting them as a four bit counter. Feed a clock signal to the clock input of F1, the Q-bar output of F1 to the clock input of F2 and so on. Monitor the Q outputs with the four LEDs.

The LSI counter and decoder can be checked in a similar manner. Connect the clock to the clock input, the counter outputs to the decoder inputs, and the LEDs to the decoder outputs. As there are not enough LEDs, you will not be able to monitor all outputs, but an indication of correct operation should be obtainable.

If any section fails to work correctly, and no constructor-generated faults such as solder bridges can be found, then the IC in question may be faulty, and should be replaced. To do this, first remove as

much solder as possible from the IC leads, using a solder wick, or similar aid.

At this stage you will find the IC still attached to the board. Do not attempt to lever it off, as you may remove the copper tracks with it if you do so. Using a fine pointed tool, carefully lever on each pin in turn, while applying heat from the soldering iron. Work through the IC pins in numerical order.

Now remove all traces of solder from the IC pads, and then bend and fit the new IC.

In a following article we will give details of demonstration circuits which can be built using the new trainer. In the meantime, readers are referred to the article in the April 1973 issue, giving details of the earlier trainer. Almost all the circuits given in that article can be demonstrated with the new trainer. □

Regenerator & speed converter for RTTY

Using only three ICs and six transistors, this project will regenerate distorted teleprinter signals, and also change incoming and outgoing messages from 45 to 50 bauds and back again. Our estimate of the total cost of components is about \$20.00.

by DAVID EDWARDS

This project is based on a complex but relatively low cost MOS-LSI integrated circuit, which is intended mainly for use with computer data communication systems where data is transferred in "asynchronous" serial form. It is called a Universal Asynchronous Receiver-Transmitter, or UART for short.

As its name suggests, the UART is really two devices in one—a transmitter and a receiver, both concerned with digital data. The transmitter section takes parallel data, and on command transmits it in serial asynchronous or "stop-start" form, with the required start and stop bits added automatically.

The receiver section of the UART does the opposite. It will accept data words in serial asynchronous form, checking for correct start and stop bits, and then make them available to external circuitry in parallel form.

In order to make the UART universal, the baud rate, number of bits per word, parity mode and number of stop bits are all externally selectable.

By now I imagine that quite a lot of readers will be wondering just what one of these "all-seeing/all-talking" devices has to do with RTTY (radio teleprinter), and the 5-level Baudot or Murray code in particular. Well, if you can persevere

for a little longer, I will try to explain in simple terms just what a UART can do for your RTTY signals.

Let us first review the Baudot code, and the way in which a teleprinter generates and decodes these signals. Baudot is a five unit code, with characters being represented by five serially transmitted pulses. The characters are sent and received asynchronously, with standard start and stop bits used to enable the receiver to synchronise itself to the transmitter.

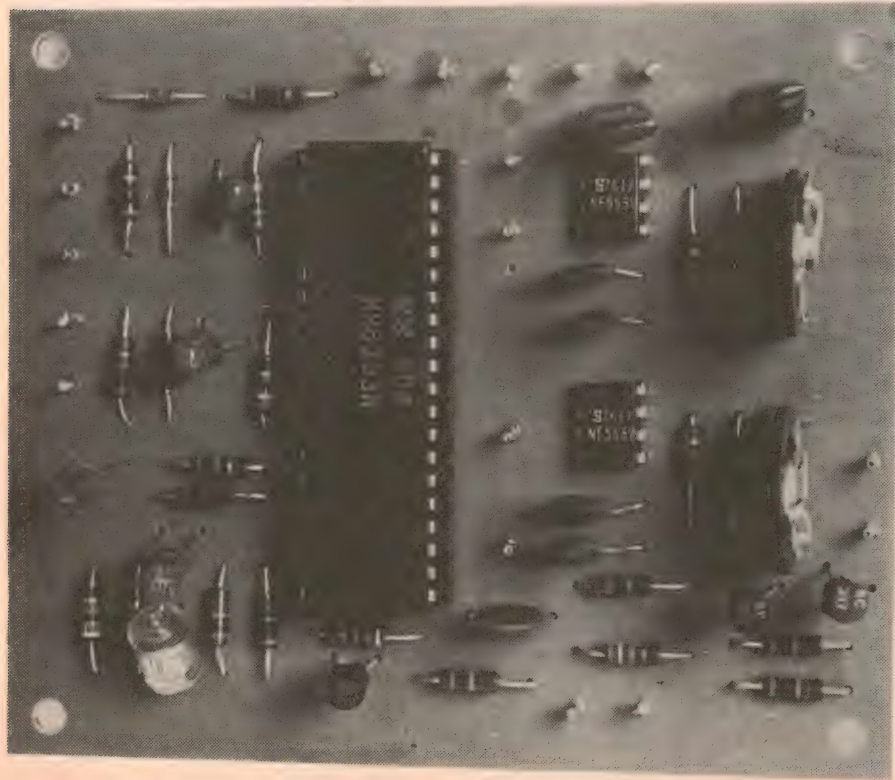
A printer unit, which is normally the receiver, decodes the characters by mechanically sampling the received serial pulse train. The start bit causes the selector magnet to engage a clutch, and this starts a mechanical timing chain.

For a 50 baud machine, five samples are taken, spaced 20mS apart in time, with the first sample being taken 30mS after the start of the start bit. The code bars, which determine which character is to be printed, are set depending on the result of the sampling.

A machine which is in good condition and is correctly adjusted will perform very well, even if there is a large amount of distortion present on the input pulse train. With very bad signals, however, the performance of the machine leaves a little to be desired.

If an erroneous start pulse is detected, say due to a noise burst, then the machine will commence its cycle, and decode the remainder of the noise pulse, and hence it will print some character. Once a start pulse has been detected, the machine cannot stop.

The receiver section of a UART is an electrical analog of this mechanical sam-

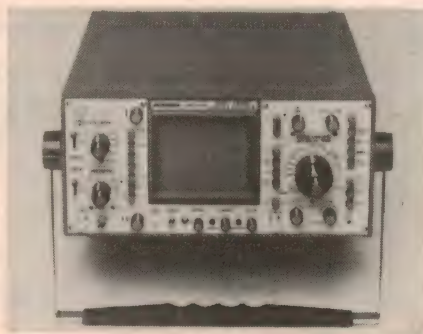


LEFT: This photograph of the assembled PCB shows just how few parts are required. Note the frequency adjusting trim pots.

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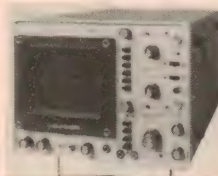
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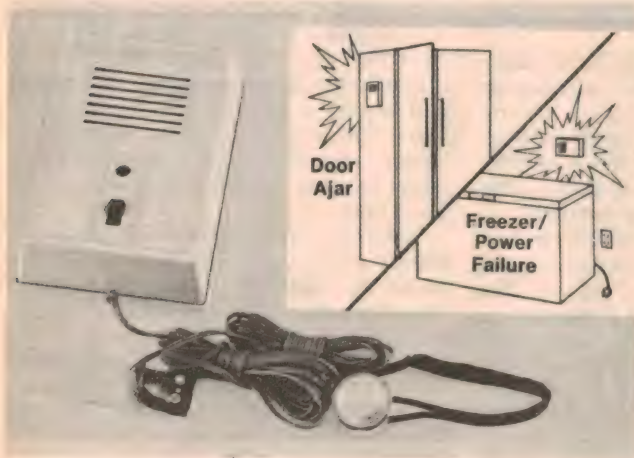
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Regenerator

after the first one, the transmitter will still be transmitting the last 15ms of the stop pulse when the receiver will signal that a second character is available.

Since in fact the transmitter is controlled by the receiver, it will forget about the remaining stop period, and commence to transmit the second character immediately. Hence for characters arriving at the input to the receiver at a rate greater than the maximum character rate of a 45 baud signal, part of the stop pulse will be lost.

For characters arriving at a lower rate, the full stop pulse will be transmitted. But if we attempt to convert 50 baud signals with tightly-packed characters (such as from a tape) to 45 bauds, 15ms will be chopped off the stop pulse of each character. Whether this will cause the printer to decode improperly is indeterminate. If the printer mechanism is able to stop in this shorter time, then all will be well.

To test this, we attempted to decode a 50 baud signal on a 45 baud machine. Much to our surprise, the test message decoded correctly. However, this may not occur with all machines.

But in any case there is a fairly simple way to ensure that all signals from the UART are acceptable to all machines: when converting to a lower baud rate, (i.e., from 50 to 45 bauds), do not type faster than the character repetition rate corresponding to the lower baud rate. So for a 50 to 45 baud conversion simply type at a normal 45 baud rate.

Since most amateur operators probably cannot type at these speeds anyway, this limitation is really only important for copy originating from a tape reader.

Note also that if a 45 baud signal is converted to 50 bauds, and then recorded on tape, it will be possible on replay to reconvert it to 45 bauds without any distortion occurring, because the characters will still have a 45 baud repetition rate.

Turning now to the circuit diagram, we should now be able to follow the operation of the circuit in more detail. Two 555 timers are used as clock generators. One is set for 800Hz, corresponding to 50 bauds, and the other set for 727.3Hz, corresponding to 45 bauds.

Switches S1 and S2 enable either clock to be connected to the receiver or transmitter sections of the UART. Thus either 45 to 50 bauds signals can be regenerated, and 45 baud signals can be converted to 50 bauds and vice versa.

S3 is provided for RTTY transmit/receive switching. It allows the operator to select either the teleprinter keyboard or the receiver demodulator output as the input to the receiver. The keyboard is provided with debounce circuitry, while the demodulator input is intended to be supplied from the demodulator



ABOVE: This actual sized reproduction of the printed circuit board pattern may be copied or traced if desired.

described in the March 1977 issue.

The selector signal is buffered and inverted by a transistor, and applied to pin 20, the input of the UART receiver. When the receiver has accepted a valid character, it makes it available on the five data lines, and drives pin 19 high to indicate this state of affairs.

The signal from pin 19 is inverted, and passed to pin 23. This tells the transmitter section that a character is available. The transmitter accepts this character, and proceeds to send it in serial form from pin 25.

The signal from pin 19 is also delayed by the 10k/470pF R-C combination, and then buffered and inverted by a further transistor, and applied to pin 18. This tells the receiver that the character has been accepted by the transmitter, and starts it searching for a new character. The delay is required mainly to ensure that the transmitter has enough time to accept and store the character; it is also required by some UARTS.

The UART transmitter output is buffered by a transistor, and turned into a 20mA current suitable for driving the printer. This signal is also made available for driving an FSK modulator, such as the one described in the May 1977 issue.

A UART reset facility is provided when the unit is first turned on by the 470ohm/0.047uF R-C combination connected to pin 21. This ensures that no spurious characters are sent when the unit is first energised.

PARTS LIST

SEMICONDUCTORS

- 1 UART: S1883, AY-5-1012, MM5303N or similar
- 2 555 timer ICs
- 6 NPN switching transistors, BC548, BC338 or similar
- 3 silicon signal diodes, 1N914, 1N4148 or similar

CAPACITORS

- 1 1.5uF 35VW tantalum electrolytic
- 2 0.1uF polyester
- 1 0.047uF polyester
- 4 0.01uF polyester
- 1 470pF polystyrene or ceramic

RESISTORS (all 1/4W)

- 2 120k, 1 47k, 2 15k, 9 10k, 1 5.6k, 1 3.3k, 2 1k, 1 470 ohm, 1 180 ohm, 1 68 ohm, 2 47k trimpots (0.2" lead spacing)

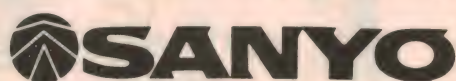
MISCELLANEOUS

- 1 printed circuit board, coded 77tty7, 86 x 102mm
- 1 40-pin DIL socket
- 4 9.5mm (3/8") PCB standoffs
- 18 PCB pins
- 3 SPDT miniature toggle switches

Solder, hook-up wire, power supply and case (see text)

NOTE: Resistor wattage ratings and capacitor voltage ratings are those used for our prototype. Components with high ratings may generally be used provided they are physically compatible.

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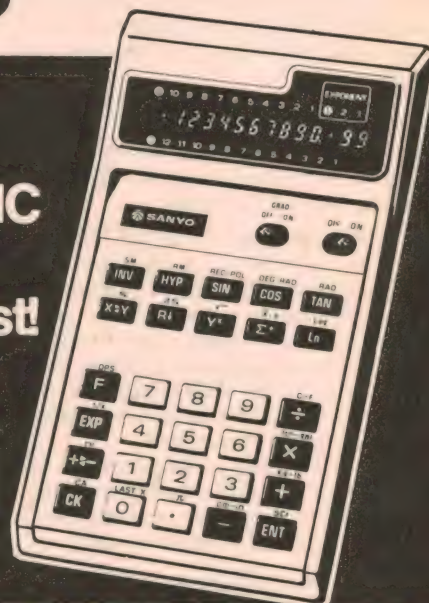
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RTTY Regenerator

The pins we have shown connected to the +5V rail and to ground are inputs to the control logic of the UART. They enable the UART to be programmed for different numbers of data bits and stop bits, as well as for other more specialised functions which do not concern us here.

We have arranged these inputs so that the UART will send and receive a 5 bit code, with 1½ stop bits, as required by the Baudot-Murray code.

The unit requires two power supplies, +5V and -12V. The latter is used only to bias the substrate of the UART chip, and draws only 3.5mA approx. The +5V rail supplies the UART, the 555s and the

There is no provision on the board for any power supply components. Fig. 2 shows a simple supply implemented using readily available components, which can be easily constructed on tag-strip, Veroboard or similar breadboarding aids. While we have specified a zener diode regulator for the 5V rail, one of the lower rated three terminal IC regulators could also be used.

If you do not wish to avail yourself of the speed change facility but only wish to use the unit as a regenerator, one of the 555s and the associated components can be deleted, and both UART clock inputs wired directly to the remaining 555. Provision has been made for this on

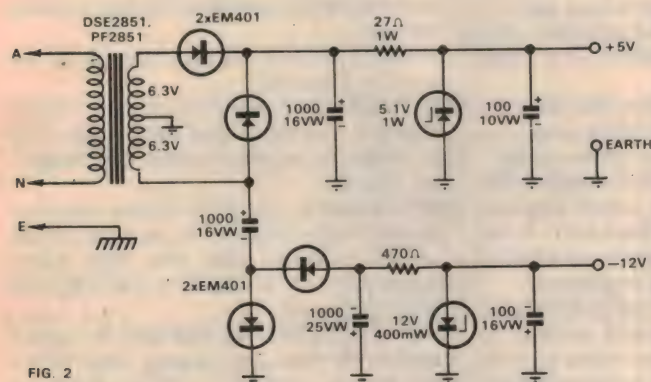
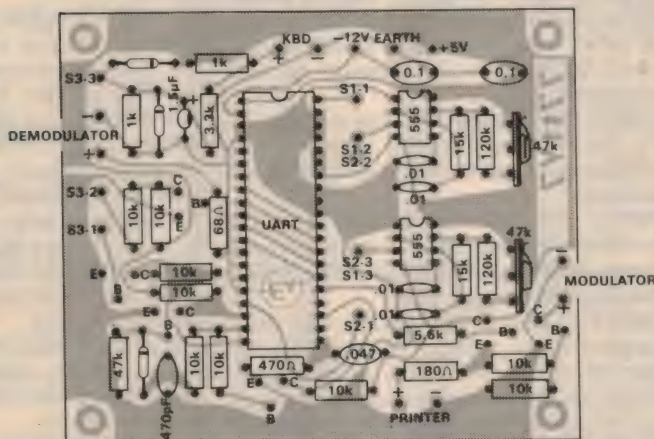


FIG. 2

LEFT: This simple power supply is adequate to run the regenerator / translator unit. The transformer specified is a small readily available unit.

RIGHT: Use this diagram in conjunction with the circuit diagram when assembling the components on the PCB.



input and output stages. With the keyboard and printer outputs shorted, we measured the current drain of the complete prototype to be only 35mA.

We assembled the prototype on a small printed circuit board, coded 77ty7, and measuring 86 x 102mm. We used a socket for the UART, since it is a MOS device and can be damaged by static electricity. This enables the remaining components to be fitted to the board, and the clocks to be adjusted before the UART is connected into the circuit.

the PCB.

Similarly if not required, the modulator and demodulator driver sections can be left off.

We have not described a case for the unit, as we felt that this would be best left up to the constructor. We envisage that S1 and S2 will be placed in line together, as they will normally be operated in conjunction with one another. None of the connections to or from the board need be shielded, as all signals are at a high level.

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Op-Amp terms explained

The author of our practical series of introductory articles "Op-Amps Without Tears" has provided this handy glossary of terms. It brings together all of the new terms you may have encountered in the series, with brief explanations of their meaning.

by J. BRIAN DANCE, M.SC

ACTIVE FILTER: An active filter employs some form of active device (often an operational amplifier) in a circuit which filters out certain frequencies or bands of frequencies. The filtering components are usually resistors and capacitors in the feedback network.

ANALOG DEVICE: Analog devices are employed in linear circuits in which the signal amplitude is analogous to a physical quantity. For example, in an audio amplifier, the signal level is related to the sound intensity.

BANDWIDTH: The gain of an operational amplifier falls with frequency. The bandwidth is the frequency at which the gain has fallen by 3dB or a factor of $1/\sqrt{2}$, with reference to the low frequency gain.

CHANNEL SEPARATION: If a signal is applied at the input of one amplifier of a device containing more than one amplifier, the signal will appear at very low levels at the other outputs. The channel separation is the ratio of the signal at the desired output to that at any other output; it is normally expressed in dB.

CHIP: A term commonly used to signify an integrated circuit, but one which should really be used for the silicon on which an IC or other solid state device is fabricated.

CLOSED LOOP GAIN: The gain of an operational amplifier circuit with negative feedback applied (that is, with the negative feedback loop closed).

COMMON MODE: An input signal applied to both the inverting and non-inverting inputs simultaneously is known as a common mode signal.

COMMON MODE REJECTION RATIO: The common mode rejection ratio is a measure of the ability of an amplifier to reject signals applied to both the inverting and non-inverting inputs. It is equal to the gain with a signal applied to only one input divided by the gain with the signal applied to both inputs.

COMPARATOR: An operational amplifier used as a comparator compares the input signal voltages at its inverting and non-inverting inputs; the output from the comparator is either 'high' or 'low' depending on which of the input voltages is higher. Although almost any operational amplifier can be used as a comparator, amplifiers especially designed for use as comparators are available which switch very rapidly from one output state to the other.

CURRENT DIFFERENCING AMPLIFIER: A current differencing amplifier is rather like an operational amplifier, but the out-

put is dependent on the difference between two input currents rather than the difference between two input voltages. Very cheap quad current differencing amplifiers are available (See EA, Nov. 1975, p. 46).

DIFFERENTIAL VOLTAGE GAIN: The differential voltage gain of an operational amplifier is the ratio of the change in the output voltage to the small change in the input voltage producing it. (See also closed loop gain and open loop gain).

DUAL AMPLIFIER: A dual amplifier contains two separate amplifiers in a single package.

DUAL-IN-LINE: Dual-in-line devices have two rows of connecting pins, one on each side of the body of the device.

FET INPUT OPERATIONAL AMPLIFIER: An operational amplifier which employs one or more field effect transistors in the input stage. One of the main advantages is that of very high input impedance.

FREQUENCY COMPENSATION: An operational amplifier would oscillate at high frequencies if one or more internal or external frequency compensating components were omitted.

HEAT SINK: A piece of shaped metal connected to a power integrated circuit, or other solid state device, which can pass heat from the device to the surrounding air.

INPUT BIAS CURRENT: The average of the two currents to the inputs of an operational amplifier with no input signal applied.

INPUT OFFSET CURRENT: The difference in the currents passing to the two inputs of an operational amplifier, when the output voltage is zero.

INPUT OFFSET VOLTAGE: The difference in the voltages which must be applied to the two inputs of an operational amplifier in order to obtain an output voltage of zero. The voltages should be applied through two input resistors of equal value.

INPUT VOLTAGE RANGE: The range of input voltages over which an amplifier will operate within its specifications.

INVERTING INPUT: A signal applied to the inverting input of an operational amplifier will produce an output signal of the opposite polarity.

LINEAR DEVICE: A device for use in a circuit in which the output voltage or current is linearly dependent on the input voltage or current. An operational amplifier is a linear device.

LOGARITHMIC AMPLIFIER: The output from a logarithmic amplifier is proportional to the logarithm of the input vol-

tage. A circuit of this type usually employs an operational amplifier with a transistor in the negative feedback network. A large range of input signal amplitudes can be compressed into a small range of output amplitudes.

MAXIMUM POWER DISSIPATION: The maximum power dissipation of a device is the maximum power which can be dissipated within that device and yet allow it to continue to operate within the manufacturer's specification and without damage.

MICROCIRCUIT: A microcircuit is an integrated circuit.

MONOLITHIC DEVICE: A monolithic device is one fabricated on a single chip of silicon or, in other words, an integrated circuit.

MOS DEVICE: An MOS device employs Metal-Oxide-Silicon FETs. In operational amplifiers these offer very high input impedance, as in the RCA CA3130 and CA3140 devices.

NON-INVERTING INPUT: A signal applied to the non-inverting input of an operational amplifier will produce an output signal of the same polarity as the input.

OFFSET NULLING: Offset nulling is the adjustment of an external variable resistor in an operational amplifier circuit so that the output voltage is made zero when both input potentials are zero.

OPEN LOOP GAIN: The open loop gain of an operational amplifier is the gain without feedback; that is, the gain with the feedback loop open circuit. This gain is normally very high indeed.

OPERATIONAL AMPLIFIER: A high gain linear amplifier with inverting and non-inverting inputs.

OUTPUT OFFSET VOLTAGE: The output voltage of the amplifier with respect to ground potential when both of the inputs are grounded.

OUTPUT VOLTAGE SWING: The peak output voltage swing which can be obtained from an amplifier without any appreciable clipping of the peaks of the waveform.

POWER AMPLIFIER: An amplifier which can deliver a relatively large current and which can often operate from fairly high voltages. Power amplifiers are widely used in the audio field, but can also be used to drive servo motors, etc.

POWER DRIVER: A power driver is an amplifier with two outputs which can be used to drive a pair of complementary power transistors. The output power available from these transistors can be very high. An ordinary operational

amplifier is not very suitable for use as a power driver, since only one output is available and this cannot be used easily to drive the power transistors which require a bias difference between their input for low cross-over distortion.

PROGRAMMABLE OPERATIONAL AMPLIFIER: An operational amplifier in which some of the parameters (such as input bias current, slew rate, power consumption, noise, etc.) can be set by means of an external resistor.

QUAD AMPLIFIER: A quad amplifier contains four separate amplifiers in a single package.

QUIESCENT CURRENT: The quiescent current is the current taken from the power supply by an operational amplifier when no signal is applied to it and when no output current is being delivered.

RIPPLE REJECTION: The ratio of the peak-to-peak ripple voltage on the power supply line to the peak-to-peak ripple voltage at the output when no input is applied. The ripple rejection can often be increased by means of an additional by-passing capacitor, in which case it will vary with frequency.

SETTLING TIME: The settling time of an operational amplifier is the time delay between the application of a very quickly rising pulse at the input and the time when the output potential has settled to within a specified amount of its final value.

SHORT CIRCUIT CURRENT LIMIT: In a device with short circuit current limiting, the output current is automatically limited by the internal circuit of the device to a value which will not cause damage to the device. It is normally found in power amplifiers and regulators designed to deliver high or fairly high power outputs.

SLEW RATE: The maximum rate at which a large change of output voltage can occur is known as the slew rate; it is normally measured in V/us. It is quite different from bandwidth and only applies to signals producing a large output.

THERMAL OVERLOAD PROTECTION: Many power devices include internal circuits which reduce the output current when the temperature of the silicon chip approaches the danger level. Nevertheless, such devices should not be allowed to become so hot that this protection circuitry operates for an appreciable time.

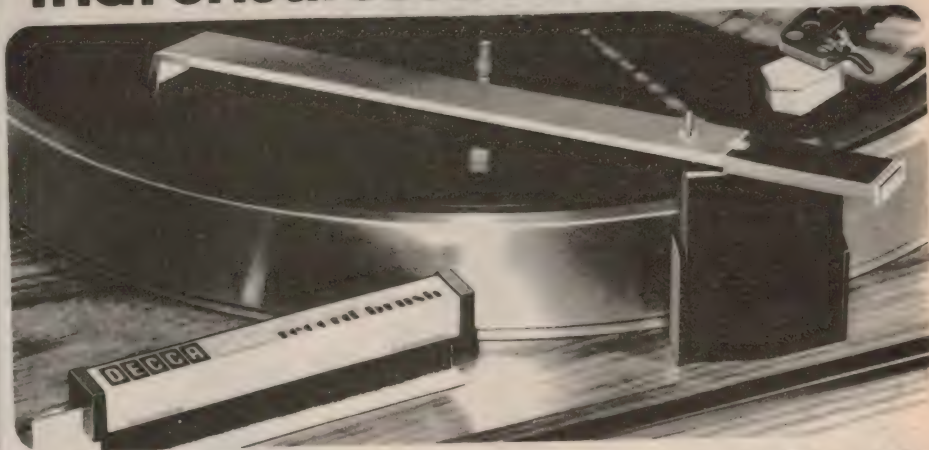
THERMAL SHUTDOWN: See "thermal overload protection".

VIDEO AMPLIFIER: A wide bandwidth amplifier. The name comes from its possible use in television receiver video circuits.

VIRTUAL GROUND: In some circuits an input of an operational amplifier remains almost at ground potential as the input signal changes; this point is said to be a virtual ground or virtual earth point.

VOLTAGE FOLLOWER: A circuit in which the output voltage closely follows the input voltage. It is normally an operational amplifier circuit with 100% negative feedback from the output to the inverting input.

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AUDIOANALYSIS

by Andrew Marshall

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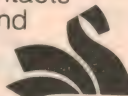
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LBV 3301

Single current converter for Creed teleprinters

The Creed Model 7 teleprinter may be available from disposals sources and is an alternative to the Teletype 15 for use with the RTTY demodulator (EA March 1977) or the ASCII/Baudot Translator (EA October 1976). This article should assist anyone building an interface for this type of machine.

by **GRAHAM LEADBEATER**
VK3ZKM

The Creed teleprinter has a number of differences from the Teletype 15. For example it does not use the conventional type basket. Instead, type blocks are carried in a drum which is rotated to the appropriate position and held there while a hammer drives the type block onto the paper.

The most obvious difference, which is noticed by anyone who operates this machine for the first time, is that on receipt of a character, the printer responds to the character it received before that one. In other words, the printer will always be one character behind the keyboard. This can be disconcerting if you watch the printer while typing, but it is easy to get used to if you look at the keyboard and ignore the printer.

The machine is designed for 50 baud operation but the range of adjustment on the governor will allow it to be used at 45 baud if desired.

The keyboard contacts are a changeover with one side for mark and one for space. There is also a "Send/Receive" or "Keyboard-Off-Normal" switch which operates when any key is pressed and remains operated while that character is transmitted. This may suggest itself as a Transmit/Receive switch for your station but you will probably find

that there is not enough time for the transmitter to come on and settle down before the character is sent.

The other contacts are a bell switch (the machine does not have a mechanical bell) and an "Answer-Back" alarm switch. Answer-Back is a facility which transmits a pre-determined message when a "Who Are You?" character (Figures D) is received. This is accomplished by rotating a drum on which wards are provided cut to the marks & spaces of each character. The wards move the keyboard code bars. A mechanical interlock inhibits this facility when a "Who Are You?" signal is generated (so your machine does not answer its own enquiry).

The main electrical difference between the Creed and Teletype machines is that the former is designed for "Double Current" signalling and the latter for "Single Current".

In the double current mode, the selector magnet is a side-stable polarised device and in the absence of line current will remain where it was. It requires a current in the appropriate direction to drive it one way or the other. By convention, a negative current source is a mark and a positive current source is a space.

In the single current mode, a mark is

indicated by the presence of line current; a space by the absence of it.

Double current working has the advantage that it is less susceptible to interference, requiring a definite signal for marks and spaces, not simply the removal of a signal for a space. However, single current working is usually preferred for amateur use because of its simplicity, so we need a means of converting the machine for this mode.

The keyboard of a Creed machine may be used for a single current working simply by using the mark side of the keyboard changeover contacts to interrupt a current loop. The printer may also be used "as is" by using a spring or rubber band to provide the space bias on the selector magnet.

This is not a very satisfactory arrangement however, since it is difficult to adjust and maintain the correct tension.

A solid state Converter/Magnet Driver is shown in Fig. 1. It uses garden-variety transistors and needs no adjustment. An unregulated plus and minus 25V supply is satisfactory. Note the overvoltage protection diodes across the input. Current drain of the circuit is approximately 20mA.

The 20mA input signal is used to control a 2N3568 transistor. The collector signal from this transistor controls a complementary pair, via a 2N3645 transistor.

When the 2N3645 is turned off, the lower transistor of the pair is held off by the 10k resistor between base and emitter. The upper transistor is turned on by the 33k resistor connected to its base.

When the 2N3645 is turned on, the diode connected to its collector conducts, turning the upper transistor off, while the lower transistor is turned on by the base current provided by the 33k resistor connected to its base.

The diodes connected across the output prevent inductive spikes from destroying the output pair. Construction is not at all critical, and may be varied to suit the particular situation.

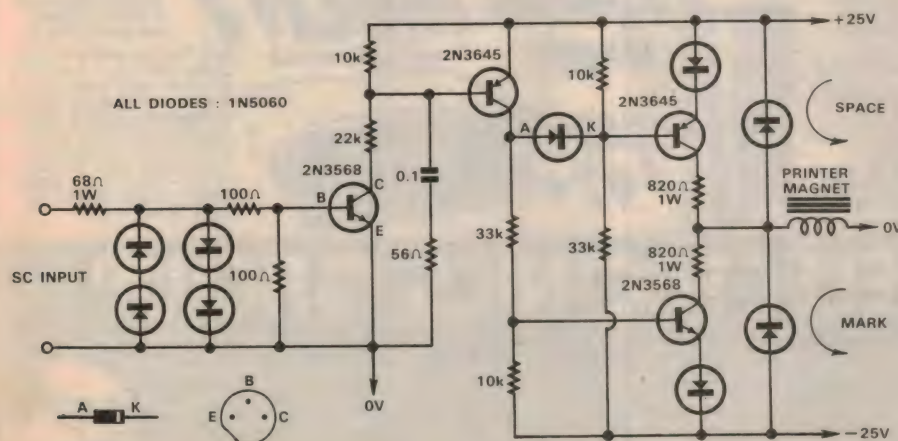


FIG. 1: SINGLE TO DOUBLE CURRENT CONVERTER/MAGNET DRIVER

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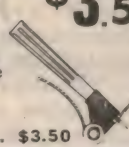


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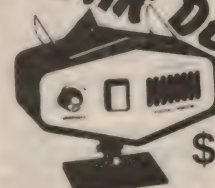
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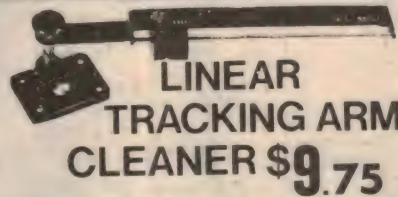
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The Serviceman

Faults that don't make sense

Most servicemen, at one time or another, have encountered a fault which "just doesn't make sense". It is not just that the fault is not in the textbooks, or in anyone's experience, since that situation is not so unusual. The real frustration comes from the fact that, even when it has been fixed, the reasons behind the fault remain obscure.

Such a situation was related to me by a colleague recently and I'm afraid I became involved, at least to the extent of trying to rationalise his findings.

The offending device was a 12in monochrome, solid state, TV set—a Kriesler model 49-6 to be precise—and it was producing the weirdest set of symptoms that either he or I had ever seen or heard of.

At full brightness, the set delivered a first class picture—except that nobody wants to look at a picture running at full brightness! But, as the brightness was turned down, each alternate line of the raster would move to the right, creating a second picture displaced to the right of the original image. There was no movement to the left by the remaining image.

The amount of separation varied with the setting of the brightness control. Bringing this down to a very dim picture produced a separation of something like four inches. My colleague confessed

that, not only had he not seen or heard of anything like it before, but that he also didn't have a clue as to the likely cause. Neither did I, at that stage—he had only just encountered it—so I wasn't much help. But I did ask that he let me know what he eventually found.

At that point, I should have forgotten about it, until my colleague came up with the answer and—hopefully—an explanation as to why the fault did what it did. In fact, I couldn't help pondering on the problem. Just what kind of defect would cause such a weird set of symptoms?

One point seemed obvious: Each alternate interlaced field was being displaced and could only mean that, in part at least, the problem must involve the 50Hz associated with the field presentation; probably the field sync pulses.

But what was actually happening invol-

ved the line structure and, therefore, must also involve the line sync mechanism in some way. This thought was further complicated by the fact that modern sets invariably use a flywheel circuit of some kind for line sync, which prevents individual lines from triggering on noise and thereby being displaced from their neighbours.

So where did that leave us? As far as I could see, it could only mean that—somehow—50Hz field information was getting into the line oscillator system, or its associated flywheel circuit, and acting as a false triggering device.

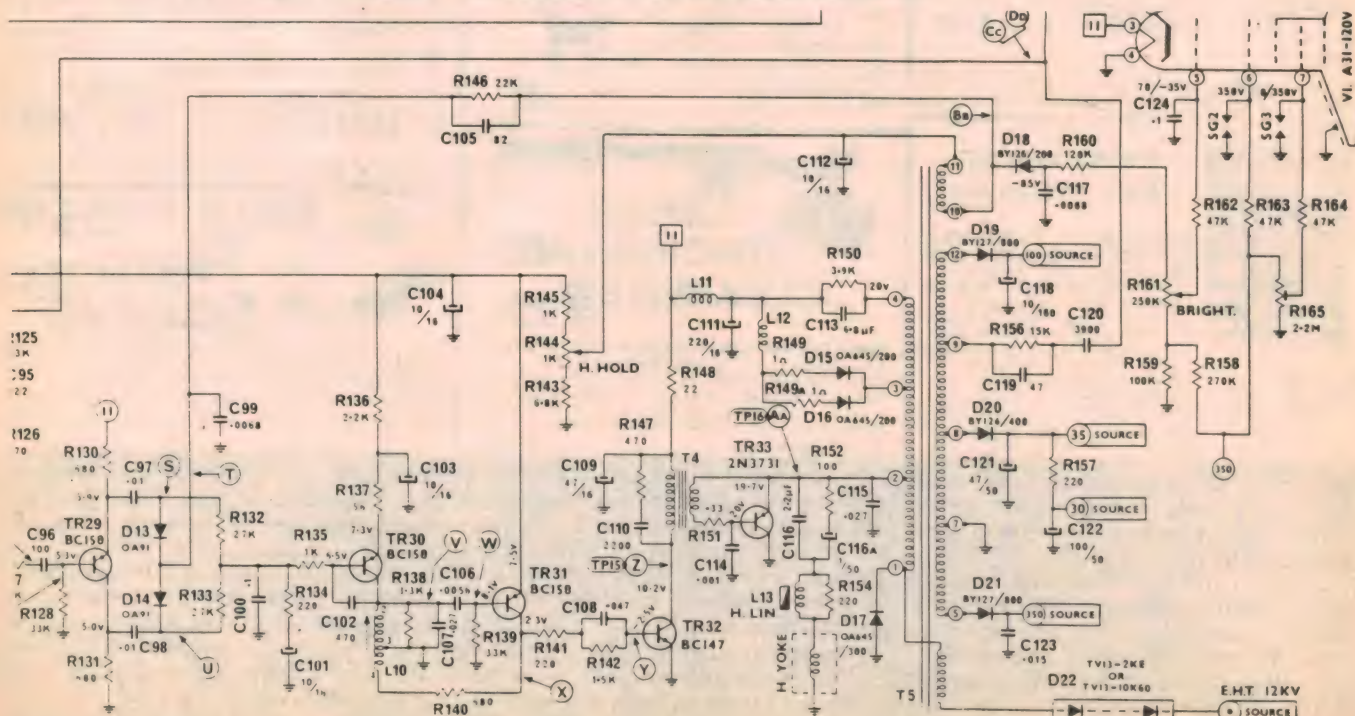
Then I realised that there was a flaw in this reasoning. Assuming that the displaced field was, say, the even line field, then whatever was displacing it would have to occur every 1/25 of a second. (There are 25 even line fields, and 25 odd line fields every second.)

Which seemed to be a nice piece of reasoning, except that it didn't provide much of an answer. Even assuming it was correct, it was still necessary to nominate (1), the source of these pulses and, (2) how they were getting into the line oscillator/flywheel circuits.

And that was about as far as my reasoning went at that stage. For one thing, I had my own work to attend to. For another, I had not seen the actual symptoms. No matter how well a faulty image may be described, there is nothing like seeing it for yourself. It is surprising how often some apparently minor detail can provide a clue.

In the meantime—as I later learned—my colleague had been reasoning along broadly similar lines; that, since it was the horizontal lines that were being

Relevant portion of the TV receiver circuit. The fault was found—by accident—to be due to a faulty electrolytic, C116A. Note the horizontal hold control circuit and its association with the line output transformer.



displaced, the fault must involve the horizontal oscillator system—the discriminator, the control stage, or the oscillator itself.

He spared me the details of what followed. Suffice it to say that he could find nothing abnormal in any of these stages. But, realising that in this set, as in most sets, the discriminator uses pulses from the line output transformer, for reference purposes, he felt impelled to carry on and check out the entire horizontal deflection system.

Unfortunately, it was all to no avail. As he put it, "I checked or replaced every likely component in the entire horizontal system without finding a fault of any kind, or even getting a clue. I was almost ready to replace the line output transformer, in desperation".

Fortunately, he didn't. Instead he continued to ponder over the circuit and probe around various components in search of inspiration. While doing so, he became intrigued by the network coupling the line output transistor to the horizontal yoke.

This was from the emitter of the transistor, through a 2.2uF mylar capacitor and the linearity coil to the yoke, the other side of the yoke going to the chassis. In parallel with the linearity coil was a 220 ohm resistor, and in parallel with the 2.2 uF capacitor was a series network of a 100 ohm resistor and a 1uF electrolytic capacitor.

Pondering on this latter network, my colleague was intrigued as to its purpose and, without much thought as to the real problem on hand, decided to lift one end of the 1uF capacitor and see what happened. He did so, and was surprised to discover that it seemed to have no effect at all.

A quick check with the ohmmeter confirmed that the resistor was intact so it was assumed that the capacitor had dried out. Still with no thought of the main problem, the capacitor was replaced as a matter of course. Imagine my colleague's feelings when the tube warmed up and he realised that the fault had vanished.

Why? Why did this component, apparently performing a relatively unimportant function, in a part of the circuit which would seem to have no bearing on the problem, prove to be the critical one? And, overall, why was the problem tied in with the setting of the brightness control?

I'm afraid I can't answer these questions. I, and others, have studied the circuit in detail and advanced a whole host of theories, without reaching any definite conclusion. Some of the theories were quite way out—but no more than the symptoms themselves.

I still favour the idea that pulses generated in the vertical deflection system were somehow getting into the horizontal discriminator circuit and shifting the phase of the system every other field.

Assuming that such pulses existed, how would they reach the discriminator circuit and what did the faulty capacitor have to do with it?

One possible path is via the yoke and, if this seems way out, there is some precedence to support the idea. Many of us, particularly those who built a monochrome set in the early days of TV, will remember that a major problem was to maintain good interlace.

Oh yes, we all knew the cause; line information getting into field sync circuits and upsetting the critical half line difference on which the interlace depends. The snag was to find the path by which this was happening; the possibilities were many and devious.

And one of the most devious was via the yoke. Line pulses in the horizontal deflection yoke were coupled magnetically into the vertical yoke from where they found their way back, via valve inter-electrode capacitances etc, until they appeared on the grid of the vertical oscillator valve, along with the genuine sync pulses. Incredible? Perhaps, but I can assure you from personal experience that it is true.

So, could it happen the other way? The suggestion is that pulses in the vertical yoke were coupled into the horizontal yoke but, in the normal situation, caused no bother because the network feeding the horizontal yoke did not favour them. But when this failed—and we don't know whether the capacitor had dried out or gone leaky—it may have been possible for the pulses to appear at the primary of the output transformer.

Once this far, it would be easy for them to find their way back to the discriminator. In fact, the discriminator is fed with a combination of DC voltage, from the horizontal hold pot, and line pulses for reference purposes, all via a special winding on the line transformer.

And what did the brightness setting have to do with it? Superficially, it seemed significant that this same winding was used to provide part of the DC voltage, via a rectifier/capacitor network, applied to the brightness pot.

Looked at in greater detail, however, it was difficult to support this connection. It seems more likely that the brightness control effected the result by virtue of the final anode current drawn by the picture tube, and which varied with the brightness setting. Could it be that, when the output stage was working hard for maximum brightness, the spurious pulses were suppressed?

A variation on this theory was that the coupling was not via the yoke but via the power supply, due to the failure of a bypass capacitor somewhere in the supply network. Such a suggestion implies that there were really two faults and that only one had been found.

A rather more radical theory suggested that the separation was not really between the interlaced fields, but was hap-

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pening on a line by line basis in each field. As far as I can see such a situation would result in the displacement occurring every two lines, which my colleague insisted did not happen. However, had the interlace also been upset, he may have been deceived in this regard.

It would also imply that the relatively long time constant in the line oscillator and associated circuitry which provides the flywheel effect, had also been disabled by the fault.

And that is about as far as speculation went. None of the theories is particularly convincing, since they are all based on rather tenuous assumptions. If anyone can come up with a better idea, I'm ready to be convinced.

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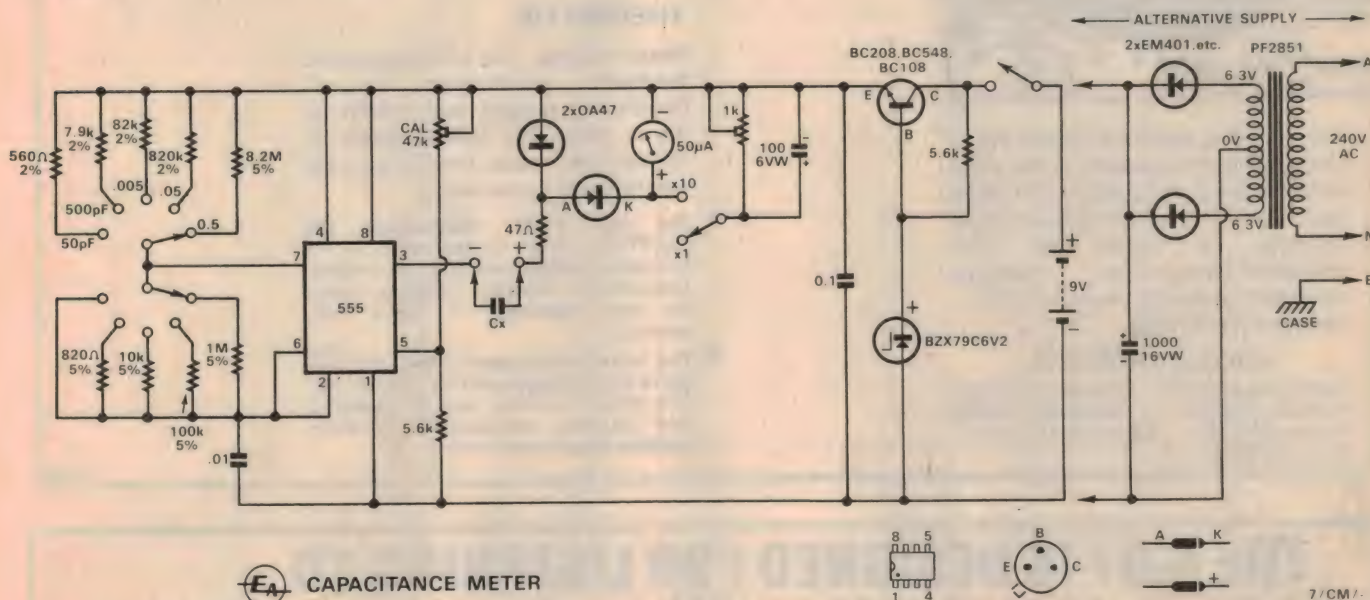
WP1121

Circuit & Design Ideas

Conducted by Ian Pogson

Interesting circuit ideas and design notes selected from technical literature, reader contributions and staff jottings. As they have not necessarily been tested in our laboratory, responsibility cannot be accepted. Your contributions are welcome, and will be paid for if used.

Improvements to Capacitance Meter



The Capacitance Meter described in October, 1976 appeared to be a useful instrument and so I decided to build one. Being rather fussy about measuring equipment, I selected 0.3% resistors for the scale multipliers. On completion and on checking with a range of precision capacitors, I found that the 50pF scale showed errors of about 20%, the next scale errors of about 5% and the other three scales were within about 1.5%.

On thinking over these errors, particularly the larger ones, the answer finally dropped into place, partly triggered by a reference in the text relating to the effective resistance of the chip into pin 7, requiring the first return resistor to pins 6 and 2 to be a shorting strap. I could

not lay my hands on the internal circuit of the 555 at the time but it occurred to me that part or all of the internal resistance might also appear in the timing feed from the battery rail. A substitution check showed the resistance input to pin 7 to be about 260 ohms.

Therefore, the solution seemed to be to reduce the values of the first two relevant resistors by 260 ohms. A trial, reducing the 820 ohm resistor to 560 ohms and the 8.2k resistor to 7.9k, resulted in all ranges being within 1.5%. I checked three different makes of 555s and found that the effective resistance does vary but the variations are not enough to be serious.

Next, it seemed logical to me to fit the

100uF "de-jitterer" capacitor permanently across the meter. This was successful and resulted in less tendency towards slamming the meter and with less need to use the X10 multiplier switch. All ranges checked OK in this mode on the test capacitors.

The two potentiometers (50k and 1k) were found to be coarse to adjust. In my case, I found that the 1k unit could be reduced to 250 ohms and the 50k unit was reduced to 25k. I would regard these modifications as optional however. With the modifications as outlined, the instrument is a delight to adjust and use.

(By Mr B. M. Byrne, 118 Central Avenue, Indooroopilly, Qld 4068.)

Modular Digital Clock as stopwatch

In the article on the Modular Digital Clock in December, 1976, no mention was made of the way in which the MA1002 module can be employed as a cheap stopwatch. When the "seconds" mode is selected, the "slow" control will hold the entire time counter, the "fast" control will reset the two seconds digits to zero, and if both the "slow" and the

"fast" controls are pressed at the same time, the time resets to 12:00:00 (or 00:00:00 for 24-hour clocks). A separate "hold" switch may also be added between pad No 1 and pad No 2. I thought that perhaps these features may be of interest to other readers.

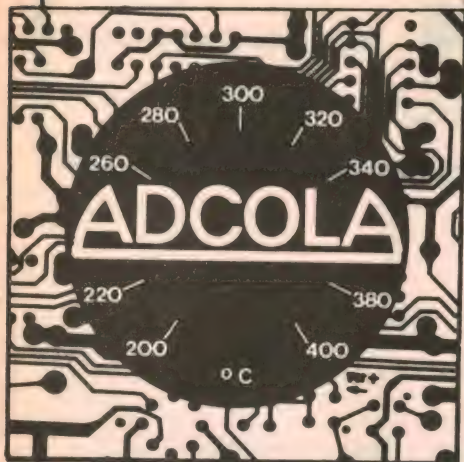
(By Mr S. D. Page, 60 Meiers Road, Indooroopilly, Qld 4068.)

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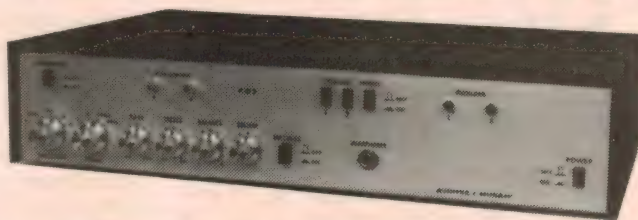
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transient wave form which lasted for that length of time has been irrevocably lost. Thus, an amplifier which appears to give quite good performance in most respects may, in fact, be robbing the listener of much of the fine detail which was in the original recording, the lack of which may be blamed on the recording itself quite unjustifiably. Transient intermodulation distortion can also cause a spitting of harsh sound from an amplifier as well as fatiguing effect, all of which are commonly blamed on "hard to listen to" loudspeakers which may, in fact, be blameless.

Unfortunately, the trend in amplifier design in recent years has been towards the achievement of very good static measurement figures, often at the expense of the dynamic performance of the amplifier. To design an amplifier in this way is not an engineering decision, but an economic one because people compare the published figures when deciding which amplifier they will buy.

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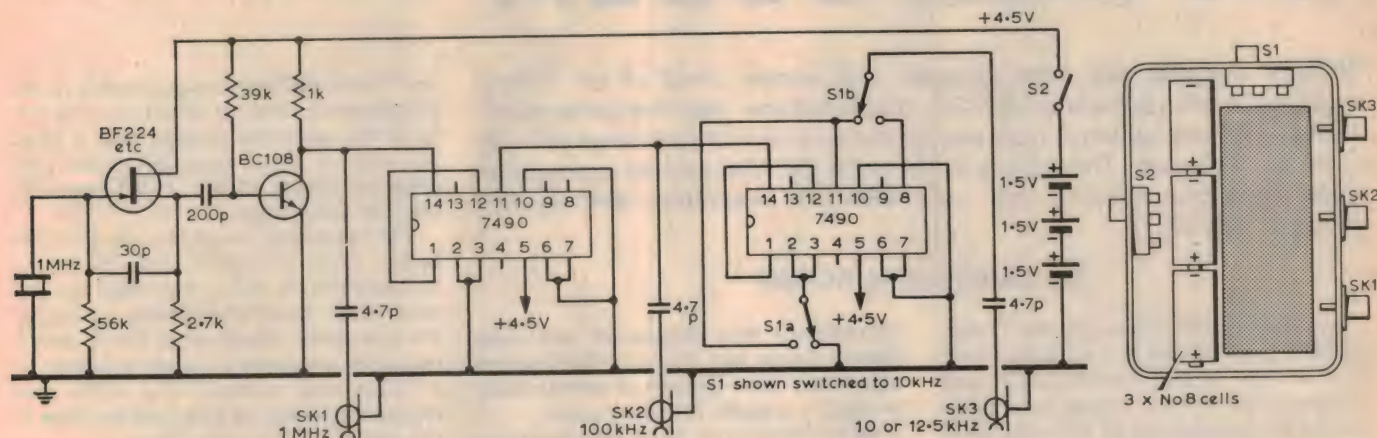
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Versatile frequency calibrator



The 7490 IC decade divider can, by variation of connections, function as a divide-by-n device, where n is any integer from 2 to 10. An interesting example of how this facility can be put to very practical use is to be found in a handy

crystal calibrator designed by G8JKL and G8ISY. This provides marker points for use up to VHF at intervals of 1MHz, 100kHz and then the option of either 10 or 12.5kHz markers.

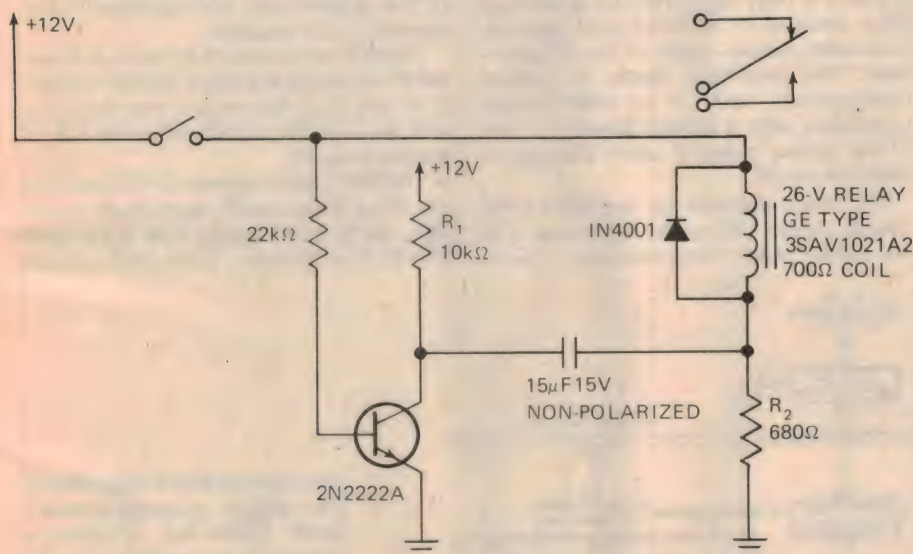
Since operation on fixed channels has

become the vogue on VHF and with a tunable receiver, the need for something better in the way of crystal calibrators than the original band-edge marker soon becomes apparent. To this end the TTL calibrator shown was designed and built. The switching allows netting on to chan-

nels as close as 25kHz apart by arranging the second 7490 to divide by either 8 or 10. The unit was built on Veroboard and was fitted into a tobacco box with three 1.5V cells.

(From "Radio Communication".)

Charged capacitor reduces relay actuating power



Operating a relay at its nominally rated voltage wastes power. Usually half that voltage or even less is enough to keep the device energised after actuation, and the same voltage can also actuate the relay if first given a boost by a simple circuit.

By using transistor to add the voltage across a charged capacitor to the source voltage, the actuator circuit energises a 26V relay with only 12V. The result is a substantial saving in power.

The capacitor is initially charged to 12V through R1 and R2 in the figure. Closing the switch applies 12V to the relay coil, and at the same time, turns on the transistor, which drops the positive side of the capacitor to ground. This effectively

forces -12V on the other side of the capacitor, and the relay pulls in with 24V across its coil. Once the capacitor has discharged through R2 and the coil, the approximately 7V across the relay coil is sufficient to keep it energised.

The circuit works well with 26V relays having coil resistances in the region of 1000 ohms. However, the value of R2 may have to be changed to suit the requirements of different relays.

The capacitor should be a non-polarised unit, because there will be a reverse voltage across it whenever the relay is energised. If power to the circuit is interrupted, the switch must be opened and closed to re-actuate the relay. The diode across the relay coil pro-

tections the transistor from transients.

(By John R. Nelson, in "Electronics".)

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The Intel 8080A

Without a doubt the most popular and widely used of all current microprocessors is the Intel 8080A, the first of the "second generation" devices and one which is now supported by a very broad range of hardware and software. This article looks at the 8080A and its companion chips and then reviews the Intel SDK-80 evaluation and system development kit.

by JAMIESON ROWE

The Intel Corporation was the first to develop and market a microprocessor, back in 1971. In fact Intel's founder and Chairman Dr. Robert Noyce is acknowledged as the inventor of the microprocessor, and apparently still holds key patents.

The first Intel microprocessor was a 4-bit P-channel device, the 4004, with 46 instructions. This was followed by an enhanced 4-bit device with a repertoire of 60 instructions, the 4040. Then in 1973 came the first P-channel 8-bit processor, the 8008. This had a repertoire of 48 instructions, and an instruction cycle time of 20 μ s (now 12.5 μ s).

But undoubtedly the most popular Intel microprocessor to date has been the 8080, an enhancement of the 8008 which came on the market in early 1974. An N-channel device, the 8080 is about 10 times faster than its predecessor. It also has a larger instruction repertoire of 78 instructions.

The 8080 has been the most popular

microprocessor ever produced, and even though it may lack some of the features offered by later devices, it seems likely to remain popular for many years.

Intel themselves have announced a number of newer microprocessors, including a more self-contained device called the 8085 and a one-chip microcomputer with internal ROM and RAM called the 8048. But they are at pains to point out that these newer chips are not regarded as superseding the 8080.

One of the prime attractions of the 8080 from the commercial point of view is that it is now supported by a tremendous amount of software and applications information—much of it user generated. This inevitably tends to reduce development costs of an 8080 system compared with a system based on one of the newer chips, if other considerations are equal.

The block diagram for the 8080 CPU chip is shown below. Its architecture is not unlike many minicomputers. There

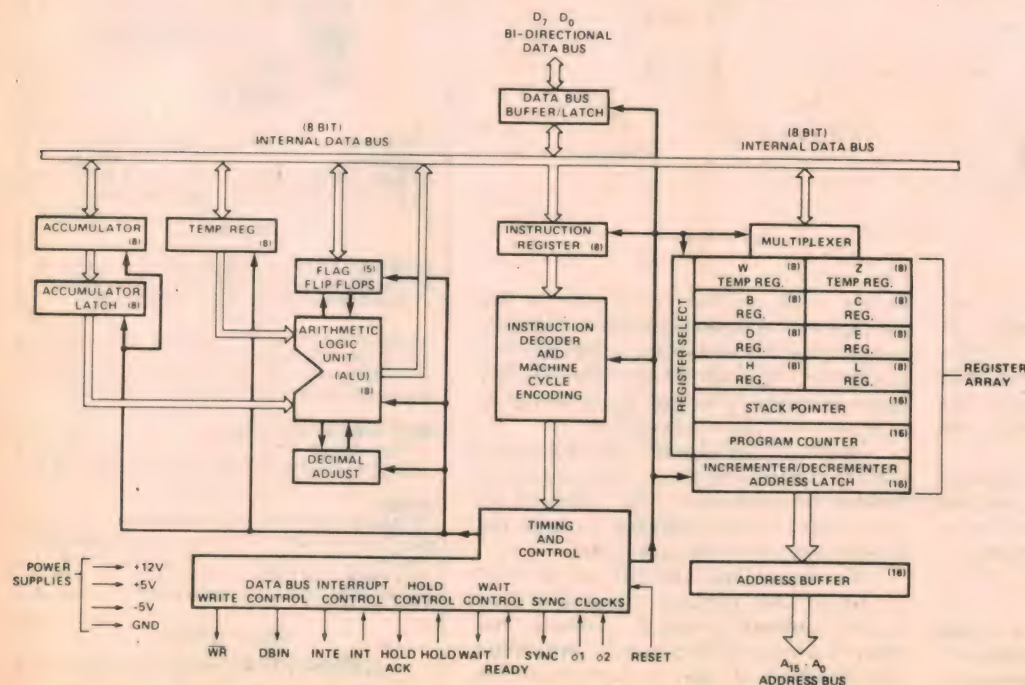
are 10 internal registers accessible to the programmer, two of which are 16 bits long: the program counter and a stack pointer. A third register called the Program Status Word (PSW) provides the five status flags.

The remaining 7 registers are all 8 bits long. One is the single primary accumulator A, while the other six are secondary accumulator/data counters. Two of these, designated the H and L registers, are generally used together as a 16-bit data counter. The other four registers can also be grouped together in this way for some instructions.

Data and address information pass between the 8080 and the rest of a system via two separate buses, an 8-bit bidirectional data bus and a 16-bit address bus. The latter gives the 8080 the ability to directly address 65,536 or "65k" bytes of memory. The output buffers on both the data and address bus lines are 3-state, and may be disabled for external control of the system bus. This facilitates DMA operation, for example.

The 8080 implements its stack in external RAM, and as the stack pointer register is 16 bits long this means that the stack may be virtually anywhere in the 65k of memory space.

The 8080 status register or PSW has five flag bits. These signify zero result, result sign, carry, even parity, and 4 bit carry (for BCD arithmetic). None of the status



A functional block diagram for the 8080A microprocessor itself. There are 10 internal registers accessible to the programmer, two of which are 16 bits long: the program counter and the stack pointer. Apart from the 8-bit primary accumulator A there are six secondary accumulator/data counter registers and a 5-bit status register.

flags is accessible directly via external device pins, only internally via certain instructions.

Although I/O devices may be interfaced so that they appear in 8080 memory space, and are accessed via memory address instructions, the 8080 also has facilities for separate I/O addressing. 8 bits are allocated for peripheral addresses, so that there is potential for addressing up to 256 input ports and 256 output ports quite separately from normal memory space.

The 8080 chip uses N-channel silicon gate MOS technology. It requires three operating voltages: +5V, -5V and +12V.

There is no clock oscillator on the 8080 chip itself, which requires high level non-overlapping two phase clock signals. These are normally provided by the 8224, a companion device designed specifically as a clock generator and driver. It also provides synchronisation for certain system control signals.

Some of the system control signals generated by the 8080 are multiplexed out on the data bus lines, during one of the clock phases. To provide demultiplexing of these signals most 8080 systems use another companion device, the 8228 System Controller.

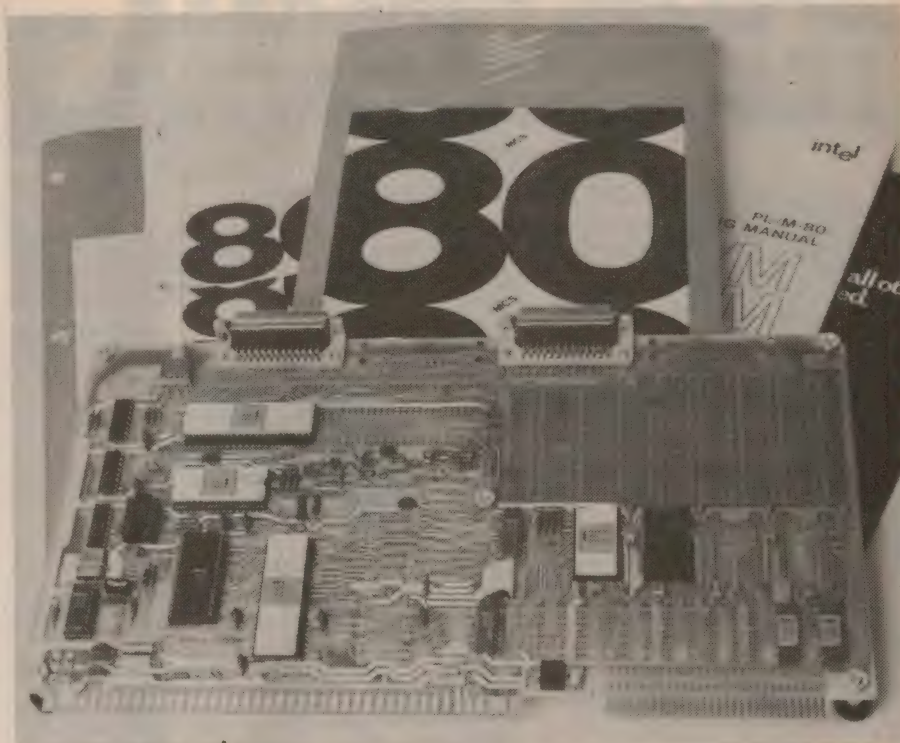
Actually the 8228 is not only a control signal demultiplexer, but a transceiver/driver for the data bus as well. And it also provides automatic control of 8080 interrupt vectoring—providing a hardware generated vector itself when none is provided by the interrupt source.

In responding to an interrupt request, the 8080 looks for an externally-supplied vectoring instruction. In most cases this is a one-byte jump to subroutine or RST instruction, capable of specifying one of eight subroutine starting addresses in the first 63 bytes of memory space. However for systems required to service more than eight interrupt sources, it is possible to use a 3-byte CALL instruction to routines anywhere in memory space.

Apart from the 8224 and 8228, Intel has provided the 8080 with a number of support devices to facilitate system design. Among these devices are the 8212 8-bit I/O port, the 8255 Programmable Peripheral Interface—which provides 24 bits of bidirectional parallel interfacing—and the 8251 Programmable Communication Interface which is basically a USART with programmable formatting and control.

There is also a large and still growing family of memory devices, with ROMs and PROMs as well as RAMs. These include a 2k byte mask-programmed ROM and a 1k byte UV-erasable PROM, with larger devices coming.

Also coming are more specialised interfacing devices, such as a programmable DMA controller, a programmable



The smallest 8080A-based system available from Intel themselves is the SDK-80 assemble-it-yourself kit, shown here assembled and with its accompanying manuals. A review of the kit is given in this article.

interrupt controller and a floppy disk controller and formatter.

The instruction set of the 8080 includes 1, 2 and 3-byte instructions. While it is nominally said to comprise 78 different instructions, in fact almost all of the 256 possible op codes are used for distinct instruction variants.

Thus the data move or MOV instruction actually has 63 different variants, with different sources and destinations specified—including 14 which involve implied memory addressing. Similarly each of the 8 accumulator operate instructions has 8 variants, while the increment and decrement instructions have 12 variants each.

Included in the 8080 repertoire are 10 jump instructions, 9 CALL and 8 RST instructions for subroutine calling, 9 subroutine return instructions, 10 instructions for operating on the stack, and 20 immediate-addressing data instructions—four of which handle 16-bit data.

Apart from immediate addressing, the 8080 provides only two memory addressing modes. One is direct absolute addressing, used for 3-byte load, store, jump and call instructions. The other mode is implied addressing, used for all other memory reference instructions. These are all 1-byte instructions, and generally use the H and L registers as a 16-bit data counter.

An interesting aspect of the 3-byte instructions using direct absolute addressing is that the second instruction

byte carries the eight LEAST significant address bits, with the third byte having the eight MOST significant bits. This is the opposite of the scheme used by virtually all other microprocessors, and slightly confusing at first. However, it doesn't take long to make the mental adjustment.

The variety of conditional branching instructions provided by the 8080 is quite impressive. Each of the three types of conditional branch instruction (jump, call and return) has eight condition tests available: not zero, zero, no carry, carry, parity odd, parity even, plus, and minus.

This feature makes it possible to write very compact and efficient programs for the 8080, particularly if liberal use can be made of subroutines and nesting.

In short, although it was one of the first 8-bit microprocessors developed, the 8080 has a powerful instruction set and compares well in this respect with many of the later chips. This together with the large amount of support available on the software side still makes the 8080 a very popular device.

Intel itself has produced a number of microcomputer systems based on the 8080, ranging from quite pretentious development systems with floppy discs and in-circuit emulation facilities down to single-board systems for OEM applications. Generally these are supplied as completely wired and tested systems.

Quite apart from these is the SDK-80

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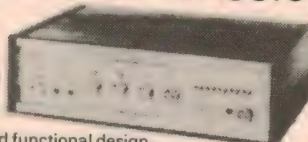
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GETTING INTO MICROPROCESSORS

System Design Kit, a small 8080 system sold as a kit and designed as a low cost evaluation and prototyping tool.

A sample of the SDK-80 kit was made available to us for evaluation by the new Australian distributors for Intel, Warburton Franki Pty Ltd. We were thus able to see how the kit goes together, and to use it to try our hand at programming an 8080-based system.

The SDK-80 provides all parts required to build a complete single-board 8080 system. The kit comes together with a set of literature which includes an 8080 user's manual, an assembly language programming manual, kit instructions and a user's guide for the SDK-80 itself, a programming reference card and other material.

When assembled the SDK-80 provides an 8080 system with 256 bytes of RAM and a 1k-byte ROM containing a monitor-debug program. A 1k-byte EPROM is also provided for user program storage. In addition, the PC board provides decoding and DIL locations for simple expansion of the system to one having 1k bytes of RAM and 4k bytes of ROM/PROM, merely by wiring in the additional memory chips.

The kit also provides an 8255 programmable peripheral interface (PPI), giving 24 bits of parallel I/O interfacing. A second 8255 is provided for on the PCB pattern, to provide a further 24 bits if desired. In addition the kit includes an 8251 USART for communication with a teleprinter, video terminal or another serial terminal. This is supported by a baud-rate generator deriving 7 standard data rates from the 8080 system clock: 75, 110, 300, 600, 1200, 2400 and 4800 baud.

The serial interfacing may be set by jumpers for either 20mA current loop, RS232-type voltage levels or TTL logic levels. All other interfaces to the SDK-80 are TTL compatible, including the 8255 parallel interface.

Two 25-pin RS232C sockets are provided on the PCB for interfacing, and matching plugs are provided. There is also provision on the PCB for address bus buffering, so that the SDK-80 may be expanded beyond the PCB via the main edge connector.

The monitor program which comes with the SDK-80, in the ROM, provides six basic commands. These are listed below, together with the command letter:

Display memory contents..... D
Move blocks of memory M
Substitute memory locations S
Insert hex code I
Examine registers X
Go to user program G

Normally the I command is used for feeding in a user program from the terminal keyboard, and the D command for checking that it has been entered cor-

rectly. The S command can be used to correct or otherwise change instructions or data in memory, and the X command to set the 8080 registers before a program is run, by then using the G command.

The M command is a rather powerful one, making it possible to move a block of instructions or data along in memory. This can save a lot of tedious re-entering, for example, if you discover you have left out an essential instruction near the start of a program!

To my knowledge no other small microprocessor evaluation kit has a monitor program providing such a "move" command, which is generally found on more pretentious systems. So the SDK-80 is rather unique in this respect.

On the other hand most other evaluation kits have monitors which provide commands to allow a program in memory to be dumped onto paper tape or cassette, and then reloaded again next time. Strangely enough the SDK-80 monitor doesn't seem to provide commands for this purpose: while the D command could be used for dumping, the dumping format is not compatible with that used by the I command.

This seems a disappointing oversight on the part of the SDK-80 designers. I suspect most users would have been prepared to forego the luxury of the M command, if this had been necessary in order to provide for convenient dumping and loading of programs.

It took about 7 hours to assemble the SDK-80 from the kit, taking care with the soldering as the PCB has narrow conductors and closely spaced pads. I found the kit assembly instructions quite clear, although one has to be careful when it comes to fitting the various option links. The designers have provided an almost bewildering array of options, in an effort to make the kit as flexible as possible.

The finished unit requires three power supplies: +5V at 1.3A, +12V at 350mA and -10V or -12V at 200mA.

When the sample SDK-80 was completed, I connected it to the EA Video Data Terminal and turned on the power. It responded with the encouraging message "MCS-80 KIT", and gave its prompt sign (a full-stop), to show that the monitor program was awaiting a command.

It was when I tried to "talk back" that a minor problem became apparent: nothing happened!

After a little troubleshooting, the reason for the lack of communication became apparent. In their wisdom, the SDK-80 designers have set the "mark" current level for the teleprinter keyboard input at around 40mA, double the nominal 20mA figure.

With the mechanical contacts of a normal teleprinter this current level would cause no problems, but the keyboard

NOVELTY ANSWER-BACK PROGRAM FOR INTEL SDK-80 KIT WRITTEN BY J. ROWE, ELECTRONICS AUSTRALIA APRIL 1977

```

1300 CD D0 01 LOOP:CALL CI      ;FETCH CHAR FROM TERMNL
1303 5F                      MOV E,A      ;COPY INTO E
1304 4F                      MOV C,A      ;AND INTO C
1305 CD E3 01              CALL CO      ;NOW ECHO
1308 7B                      MOV A,E      ;RESTORE IN A
1309 E6 7F                  ANI 7FH      ;STRIP OFF PARITY
130B EE 0D                  XRI 0DH      ;WAS IT A CR?
130D C2 00 13              JNZ LOOP      ;NO -- CONTINUE
1310 0E 0A                  MVI C,0AH    ;YES -- SUPPLY LF
1312 CD E3 01              CALL CO
1315 21 26 13              LXI H,2613    ;SET UP H&L AS ANSWER POINTER
1318 4E                      ANSR:MOV C,M ;LOAD ANSWER CHAR INTO C
1319 79                      MOV A,C      ;COPY CHAR INTO A
131A FE 00                  CPI 00H      ;CHECK IF ZERO
131C CA 00 13              JZ LOOP       ;YES -- END OF ANSWER SO RETURN
131F CD E3 01              CALL CO      ;NO -- SEND TO TERMINAL
1322 23                      INX H        ;INCREMENT POINTER
1323 C3 18 13              JMP ANSR     ;AND CONTINUE
1326                      ; ANSWER BUFFER BEGINS HERE
1326 47 4F 20
1329 41 57 41
132C 59 2C 20
132F 49 27 4D
1332 20 42 55
1335 53 59 21
1338 0D 0A 00              ;ANSWER MUST END WITH A ZERO BYTE

```

Here is a short novelty program which the author wrote to run on the SDK-80 kit. Note that in 3-byte memory reference instructions, the 8080A expects the LESS significant address byte first.

output of the EA video terminal is an opto-coupler circuit designed to switch the nominal 20mA current. While it can cope with a moderately higher level, a current of 40mA causes its voltage drop to rise quite significantly, making it seem like the keyboard is continuously in the "space" condition.

As it happens the trouble is easily fixed. I simply changed the value of a resistor in the SDK-80 interfacing circuit (R19) from 430 ohms/1W to 1k/1W. This reduced the loop current to 20mA, and all was well.

Those with video terminals having opto-coupler interfacing like the EA design may also need to make this modification to the SDK-80.

Once this modification was done, I was able to use the SDK-80 to try out some simple 8080 programs and get them going. This proved to be quite straightforward using the various monitor commands, which are very helpful apart from the lack of dump and load facilities.

Among other things, I tried writing some programs which call the utility subroutines in the monitor ROM. There are a number of useful routines available, although the kit manual suggests that the user can only use the two terminal drivers. It also suggests a rather strange indirect way of calling these, but I found that it was possible to call both the drivers and a number of other subroutines directly.

To illustrate this, I am reproducing here a listing of a simple novelty program which echoes input from the terminal, and replies with a curt "GO AWAY, I'M BUSY!" when the user terminates a line with a carriage return. This program uses the two terminal driver routines CI and CO, calling them directly via their addresses in ROM (01D0 and 01E3).

It would probably be possible to make the program shorter by using the monitor subroutine ECHO instead of CO. However, even as it stands it should give you an idea of the power and flexibility of the 8080A instruction set, at least for this type of application. You could try writing a shorter version yourself, as an exercise.

Summing up, I found the SDK-80 kit fairly easy to assemble, and easy to get going apart from the minor complication caused by the high keyboard loop current. The resident monitor program provides a powerful set of commands, including a rarely-found block move function, although there seems to be no provision for dumping to and loading from tape.

All in all, though, SDK-80 seems a businesslike little system, and one which would make a good introduction to the 8080 microprocessor. It seems quite good value for money at the quoted price of \$315 plus tax.

SDK-80 kits and other Intel 8080 systems are available from Warburton Franki Pty Ltd, who have offices in each state.

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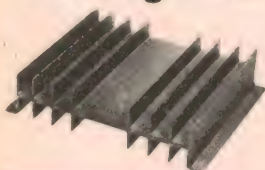
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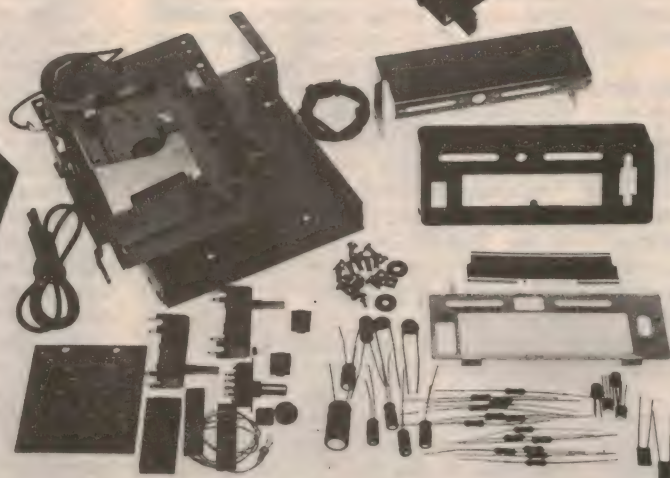


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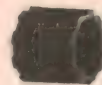
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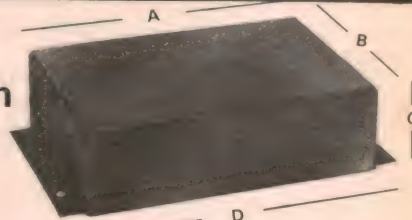
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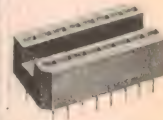
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10 mfd 25 volt	12c	10c
22 mfd 25 volt	12c	10c
33 mfd 25 volt	15c	12c
47 mfd 25 volt	15c	12c
100 mfd 25 volt	16c	14c
220 mfd 25 volt	35c	30c
470 mfd 25 volt	35c	30c
1000 mfd 25 volt	55c	47c
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3.3 mfd 50 volt	18c	13c
4.7 mfd 50 volt	20c	18c
10 mfd 50 volt	20c	18c
22 mfd 50 volt	20c	18c
33 mfd 50 volt	20c	18c
47 mfd 50 volt	20c	18c

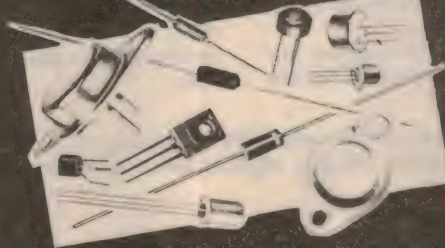
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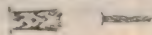


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To encourage enthusiasts to dream up and develop interesting new microprocessor applications, we are launching this exciting new contest. The idea is simple—to the individual enthusiast, student or hobby club who can come up with the most intriguing and imaginative application for the Mini Scamp microcomputer, Dick Smith Electronics will award an outstanding prize: a complete "big brother" microcomputer system valued at more than \$2000, shown opposite.

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home, office or school. Like controlling a model train layout, or running a home movie show or providing a washing machine with custom programmable washing cycles ...

The system you develop must use Mini Scamp, and its software must fit in less than 1280 bytes of RAM and/or ROM/PROM. It should preferably have been tried out in practice, to make sure there are no hidden bugs. Your entry should include a detailed description of system operation, a complete program listing with comments, and details of any custom interfacing you have used.

Judges for the contest winner will be Mini Scamp's designer Dr John Kennewell, entrepreneur Dick Smith and EA editor Jim Rowe. Their decision will be regarded as final.

Entries must be accompanied by the official entry form below (except in states where this requirement is illegal). Entries should be postmarked no later than September 30th, 1977, so you have three months to work on your entry. The winner will be announced in EA as soon as possible after that date.

CONDITIONS OF ENTRY: Entries should represent the entrant's original work. Employees of Sungravure Pty Ltd, Dick Smith Electronics Pty Ltd or any associated companies are not eligible to enter. Entries postmarked or delivered by hand later than September 30, 1977, will not be eligible.

ENTRY FORM

THE DICK SMITH—ELECTRONICS AUSTRALIA MINI SCAMP \$2000 MICROCOMPUTER CONTEST

Complete this form and attach it to your entry, posting them not later than 30th September, 1977, to Microcomputer Contest, c/o Electronics Australia, Box 163, Beaconsfield, NSW 2014. A letter may be used instead of the form in States where this requirement is illegal.

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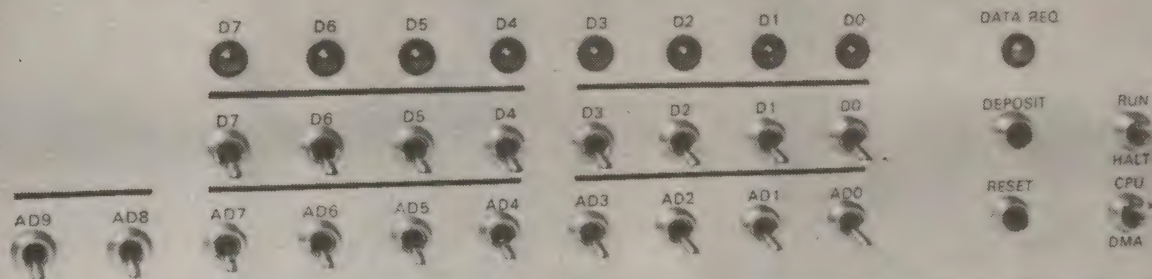
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MINI-SCAMP MICROCOMPUTER



More on Mini Scamp

Judging by the tremendous interest it has generated already, our Mini Scamp looks like becoming the most popular microcomputer project ever described. This article gives details of some simple modifications and improvements to the basic design, to improve performance. It also discusses simple techniques for providing parallel interfacing.

by JAMIESON ROWE

One good thing about a popular project like Dr. Kennewell's Mini Scamp is that with so many people building it up quickly, any errors or bugs present tend to show up sooner than otherwise!

For example, the May issue had only been published a couple of days before a reader rang to point out that there was an error in the power supply wiring diagram.

If you didn't see our note last month about that error, it showed the wire from the 12.6V transformer tap as being connected to earth. In fact it should only connect to the "+" end of the 1000uF electrolytic capacitor, of course.

It took a little longer for any other bugs to show up, but after a couple of weeks we received reports of some builders having trouble with the deposit timing circuitry. Some units wouldn't load in programs properly in DMA mode, while others wouldn't load from the switches reliably under program control.

When we looked into this, we found a subtle timing problem associated with the deposit timing delay circuit shown in the May issue. With some 1N914 diodes and BC108 transistors, charge storage times were sufficient to slow down the leading edge of the pulse used to gate the data switches onto the data lines, and improper loading occurred. Usually, some or all of the bits loaded as "1's", regardless of the switch positions.

Happily, we found a simple way of fixing this trouble. All that is required is to reduce the value of the base pulldown resistor shown as 10k, to 680 ohms. This should produce reliable loading with all devices.

In the meantime, Mini Scamp designer Dr John Kennewell advised us that he had found it desirable to add a 180-ohm resistor in series with the deposit switch. This prevents the switch from taking the B1 input of the 74123 monostable right up to the 5V rail, and thus prevents the monostable from being spuriously triggered by supply line transients.

Incidentally you may have noticed that while Dr Kennewell's original circuit as shown in the April article shows a DPDT switch used for S1, performing the DMA/CPU switching, we called for only an SPDT switch in the parts list. This is because the SPDT switch is quite capable of doing the job, if its rotor is taken to earth. In the DMA position it earths the two wires from the PCB pads marked "DMA/CPU SW A", while in the CPU position it earths the single wire from the PCB pad marked "DMA/CPU SW B". Most builders seem to have deduced this for themselves, but I mention it in case you haven't got that far as yet.

If you make these few minor corrections to your Mini Scamp, you should find that it works quite well. However something which may become apparent

once you begin running programs is that with the Mini Scamp as it stands, the LOAD SWITCHES instruction tends to result in an automatic STORE LEDS operation, whether you want this to happen or not.

This occurs because of the 1N914 diode tying the NWDS control line to the Q2-bar output of the 74123 monostable. The diode is used for DMA program loading, serving no useful purpose in CPU mode. However as it is still in circuit, it is able to cause spurious writing into the 74C175 LED latches, when the deposit switch is pressed as part of a LOAD SWITCHES instruction.

Again, there is a fairly simple way of preventing this from happening. All that is required is to replace the existing SPDT switch used for DMA/CPU selection, with a DPDT type. The second section of the new switch is then used to break the connection between the 1N914 diode and the NWDS line, in the CPU position.

You don't need to cut any PCB tracks to make this change, because the diode is normally connected to the NWDS line via a wire link. All you need do is cut the link, and connect the two cut ends to the appropriate lugs of the new DMA/CPU switch.

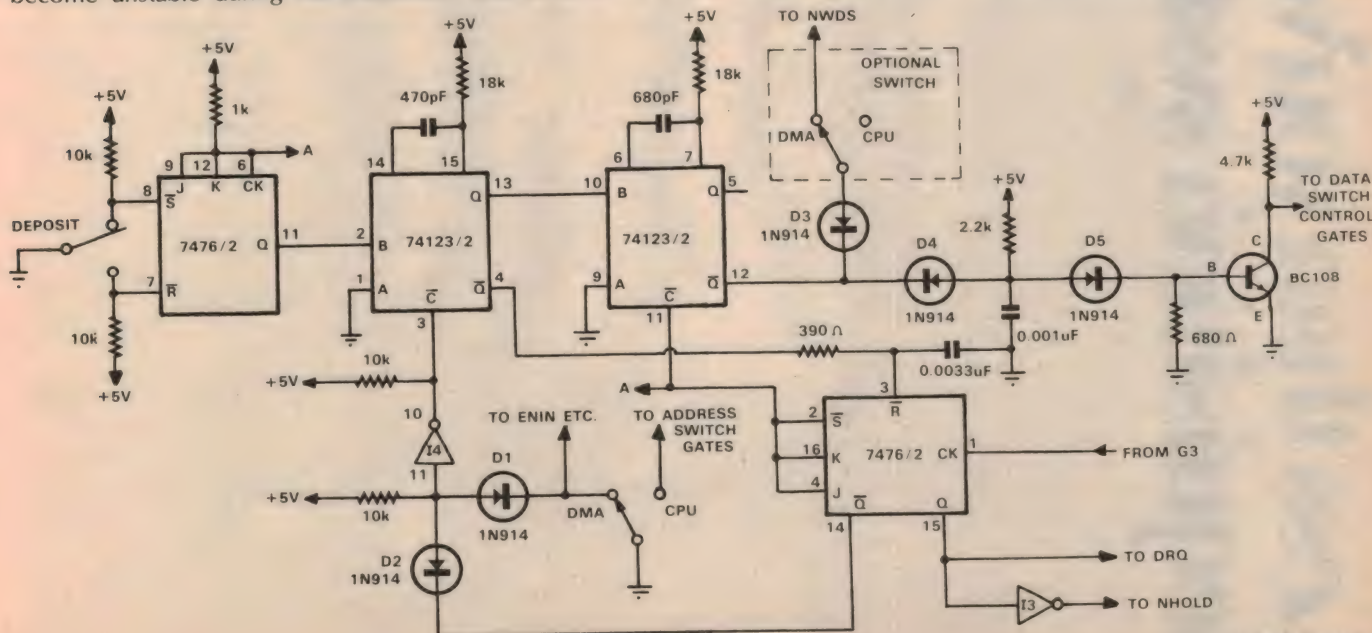
There is another modification to the basic Mini Scamp design which some builders may care to make. Although it requires a little more work, it is still fairly straightforward and involves only a handful of additional low-cost parts.

The purpose of this further modification is to ensure that only a single loading takes place from the switches when the deposit switch is pressed in CPU mode, in response to a LOAD SWITCHES instruction having lit the DRQ LED. With the existing Mini Scamp circuit multiple

Presumably the input of the 74123 can become unstable during the transition

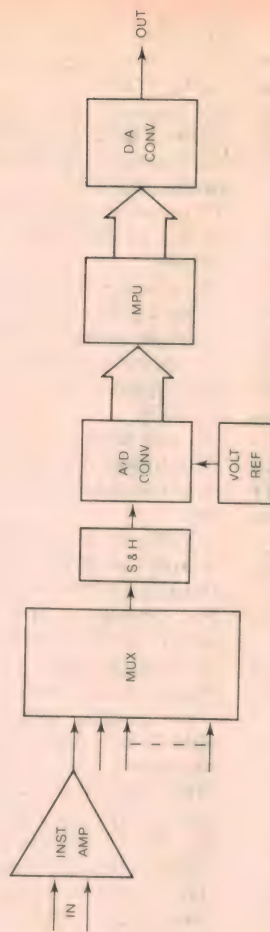
11. drill a hole near pin 11 of the 7476, and connect the loose wire attached to

For more complex applications, you may wish to provide Mini Scamp with full 8-bit parallel interface ports. This can be done fairly simply, providing you can write your program so that it isn't worried



77

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MINI SCAMP

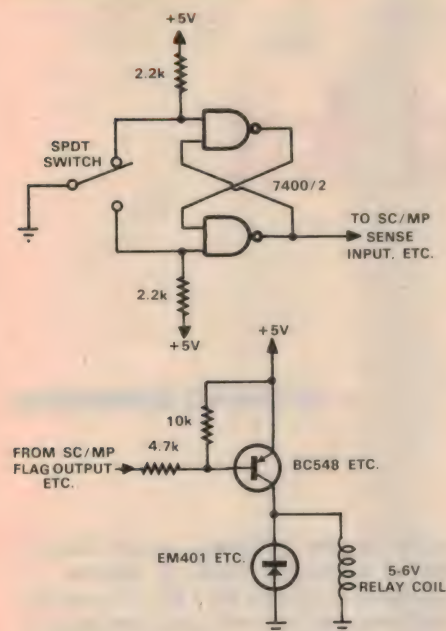


FIG. 2: SIMPLE RELAY & SWITCH INTERFACING

The three diagrams above and at right should give you some guidance on providing your Mini Scamp with interfacing to the outside world.

by the ambiguous addressing which results from incomplete decoding.

A simple latched 8-bit output port is shown in Fig. 3. Two 74C175 devices are used for the latch itself, providing both active-low and active-high outputs for the eight bits. These outputs could be used to drive external circuits via buffers like those used for driving the LEDs in Mini Scamp itself.

As you can see, the address decoding is quite simple, combining the "5" output from the 74LS138 decoder with the ADO, AD1 and AD2 address line signals to give the port an effective address of 507 hex. When a STORE instruction specifying this address is executed, the WDS pulse from I1 is allowed to reach the clock inputs of the latches, writing the data into them.

Because the gating does not sense address lines 3, 4, 5, 6 or 7, the port effectively occupies other addresses besides 507. For example it could also be addressed as 50F, 517, 51F, 527 and so on. This shouldn't cause any strife as long as you remember it when writing your programs.

The same sort of simplified addressing is used in the 8-bit input port shown in Fig. 4. Here only a single 74C10 gate element is used, in conjunction with an internal two-input enabling gate provided in the DM81LS95 octal buffer. RDS pulses from inverter 12 are only effective in enabling the buffer when

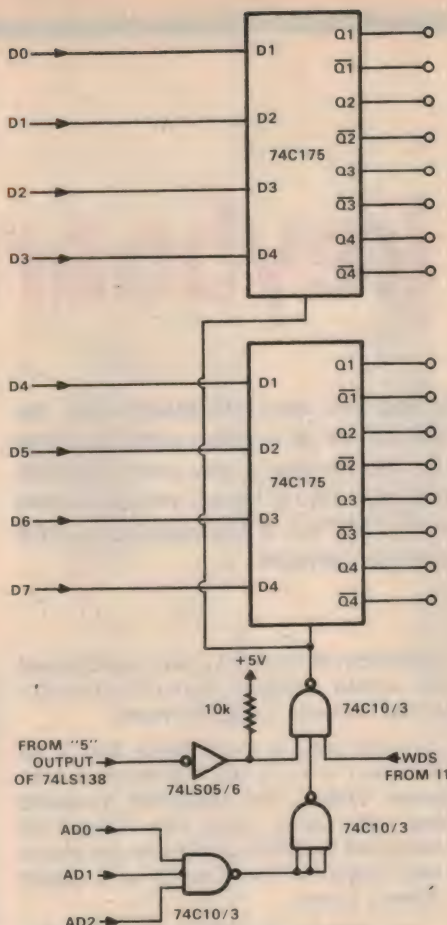


FIG. 3: SIMPLE LATCHED 8-BIT OUTPUT PORT (ADDRESS 507 HEX)

address lines AD0 and AD3 are high and the "5" output of the 74LS138 decoder is low, corresponding to address 511 hex.

Hence you can read the data from the port into the SC/MP accumulator by executing a LOAD instruction which references address 511. But because of the simple decoding, you can also regard the port as having address 513, 515, 517, 51B, 531 and so on.

Both of the circuits shown in Fig. 3 and 4 impose very low loading on the lines SC/MP address, data and control lines so you should be able to use them with Mini Scamp even if you have expanded the memory. However if you want to add a number of different ports along these lines, you may have to add extra buffering to ensure reliable operation.

NO LOADING IN CPU MODE?

A small number of readers have found that while their deposit switch functions correctly in DMA mode, it will not operate in CPU mode. This appears to be due to excessive voltage drop across the 390 ohm resistor linking the Q1-bar output of the 74123 (pin 4) to the reset input of the 7476 DRQ latch (pin 3). This prevents the DRQ latch from being reset when the deposit switch has been operated.

The cure is to reduce the resistor to 220 ohms and increase the value of the associated capacitor from 0.0033uF to 0.0068uF.

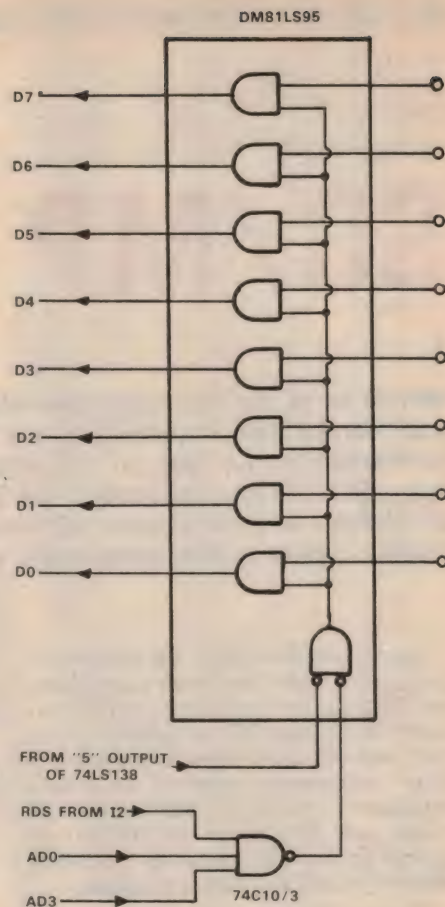
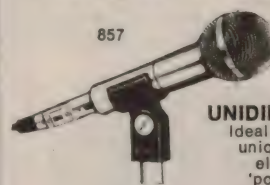


FIG. 4: SIMPLE 8-BIT INPUT PORT (ADDRESS 511 HEX)

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SC/MP keyboard kit

Almost all of the microprocessor kits that we have reviewed over the past months have required either a teleprinter or a video data terminal to interface to the user. In this article, we review a low cost addition to the SC/MP kit (reviewed in the October, 1976 issue) which allows an operator to communicate with the SC/MP via a keyboard and HEX display, and thus eliminates costly terminal devices.

by DAVID EDWARDS

The SC/MP Keyboard Kit consists of a calculator case fitted with a keyboard and a display, an "umbilical" cord to connect it to the main SC/MP printed circuit card, and the extra integrated circuits and other components required to enable the basic SC/MP kit to "talk" to the calculator unit. In addition, an MM5214 or equivalent ROM is supplied, containing the new SCMPKB monitor program.

All these components mount onto the standard SC/MP kit circuit board, using both solder and wire wrap connections. A wire tool and a quantity of pre-cut wire are supplied to facilitate the making of these latter connections.

We were supplied with a pre-assembled kit, and thus did not experience at first hand the construction method. However, the instructions

supplied with the kit are very explicit, and we would imagine that construction would be quite straightforward.

To be sure, it does seem that if an incorrect wire-wrap connection was made, finding and detecting it would pose difficulties. Only two colours of wire were supplied, and there are about three hundred joints in an area about 40mm x 70mm.

The monitor program provided enables memory locations to be examined and modified. Once a program has been entered, it can be executed. It is possible to return to the monitor program by using a special "abort" key, or by inserting an appropriate instruction in the test program.

An initialisation key is provided, although it is simply what would nor-

mally be the calculator on/off switch, and is somewhat fiddly to operate. In operation it causes the CPU to save the data registers in RAM, and then puts it into a wait loop, in preparation for a command from the KB keyboard. During this loop, the display shows a line of dashes.

The display is divided into two fields, or sections. The left hand section, comprising four digits, is used to display the address of the current memory location, while the right hand section, of two digits, is used to display the contents of that location.

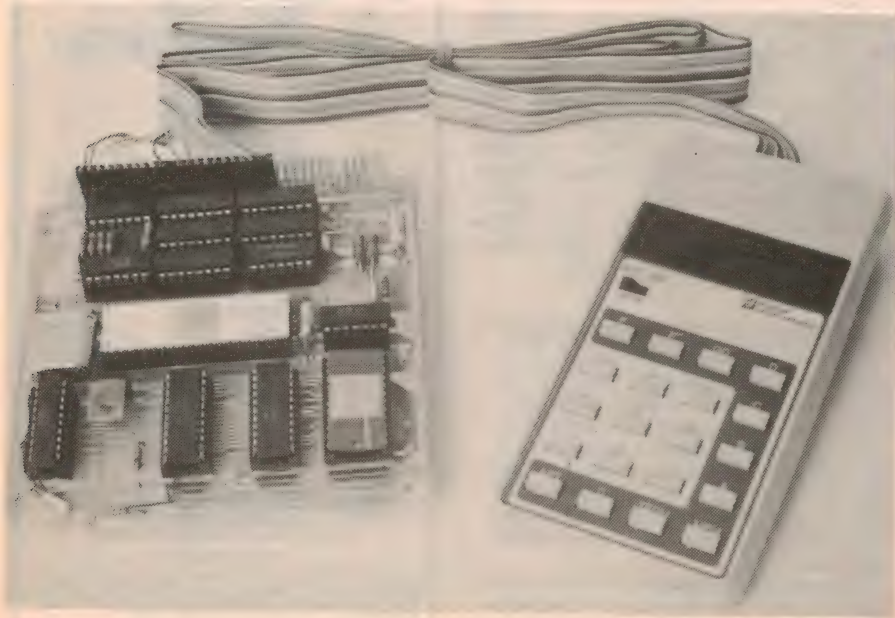
The wait loop can be exited by either pressing the GO or the MEM key. If the GO key is operated, the last referenced address is displayed, while the data field is set to dashes. A new address can then be entered, using the HEX keys, and program control is transferred to this address by pressing the TERM key.

The saved data registers are then returned to SC/MP, and program control is transferred to the specified address. To return to the command condition, an XPPC P3 instruction can be inserted in the program, or the ABT key can be used. In both these cases, the data registers are saved in RAM.

To insert programs into memory, the MEM key is used, in conjunction with the TERM key. When the MEM key is operated, the previous memory address and data are displayed in the address and data fields. Pressing the MEM key again will display the next memory address and its contents.

To modify a specific memory address, the MEM key is pressed, followed by the HEX keys representing the desired address. Once the correct address has

Add a power supply to the PCB and keyboard units shown in this photograph, and you have a working microcomputer.



been entered, pressing the TERM key will allow entry into the data field. Once the required data has been entered, the TERM key is pressed again to write the data to memory. After the data has been written, it is read back and displayed, along with the current address.

To advance to the next memory location, the MEM key is pressed again. If it is desired to enter data into this memory location, the TERM key must be pressed before the data is entered, and again after. Thus if a program is being entered into sequential memory locations, the key routine required is as follows:

MEM, HEX address of first location, TERM, HEX data, TERM, MEM, TERM, HEX data, TERM, MEM, TERM, HEX data, TERM and so on.

When entering data, we found that the keyswitches were not reliably debounced, and that it was possible to enter inadvertently several numbers, instead of a single one as desired. This was more an inconvenience than anything else, as it is a fairly simple matter to correct a wrong entry.

The keyboard/display input/output routine contained in the ROM is available to the user as a subroutine. Data can be accepted from the keyboard, and also displayed on the display. Up to eight characters can be displayed at any one time.

One small application example "program" is provided in the User's Manual. This, when entered into the appropriate section of RAM, and executed, displays the message "did Good". No explanation is given of how this program works, and budding programmers are left to decipher it alone.

Similarly, no details are given of the required codes to display particular numbers or characters on the display. The programmer is apparently left to work all this out for himself.

In conclusion, this approach is definitely economical when compared to the cost of a full terminal unit and provides all the facilities of the KITBUG command routine normally supplied with the SC/MP.

Entry and debugging of complicated programs would be a tedious job, however, due to the relatively large number of keystrokes required per entry, and the possibility of erratic entries due to switchbounce.

The keyboard kit is available from National Semiconductor, either alone or in conjunction with the SC/MP kit. The cost of the combined kit is \$180.00, plus sales tax where applicable, where the keyboard kit alone costs \$88.00, again plus tax if applicable.

For further details, refer to the advertisement on pages 76 and 77 of the June 1977 issue.



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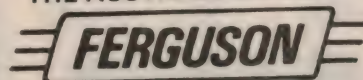
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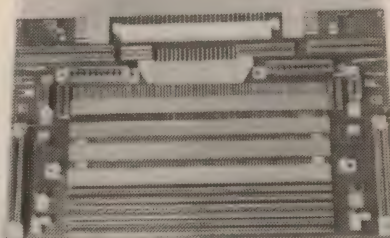
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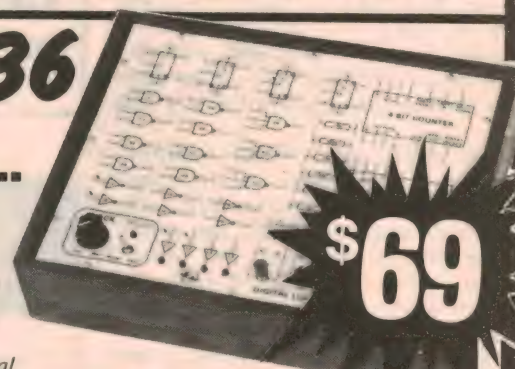
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Timing & Control

The operation of most digital systems is dependent upon a train of clock pulses fed to the various circuits to co-ordinate their functions. Other timing and gating signals may also be required, to initiate and control operation. In this chapter we look at some of the circuits used to generate these timing and control signals.

by JAMIESON ROWE

The operations performed by the various circuit sections within a digital system must often be either synchronised with one another, or arranged to take place according to a specific time sequence, to ensure the correct operation of the system as a whole. Usually the most efficient and convenient way of achieving this synchronism and/or time sequencing is to generate a train of pulses which are fed throughout the system to provide a timing reference. Logically enough these pulses are called "clock" pulses, and the circuits which generate them are known as clock generators or clock oscillators.

Quite often other timing signals are derived from the clock pulses, to further control system operation. In addition the clock pulses themselves are often used within the various circuits of the system, to ensure correct internal operation. Thus as we saw in chapters 9 and 13, the operation of both shift registers and multiplexers depends quite fundamentally upon a train of clock pulses.

In short, most digital systems include at least one clock generator, whose output pulses play a key role in overall system operation.

In many systems, the clock pulses do not have to be especially stable in terms of width or repetition rate. For such systems almost any oscillator capable of producing reasonably fast rectangular pulses may be used as a clock generator. However, there are some systems where timing stability is somewhat more critical; for these it is generally necessary to use a quartz crystal oscillator as the clock generator.

Whether the clock generator is crystal controlled or not, it is generally designed to use logic elements of the same "family" as used in the rest of the system concerned. So that if the system is based primarily on TTL devices, the clock generator will normally use TTL elements also. Similarly a clock generator for a system using CMOS and/or other MOS devices would normally use CMOS elements.

This is partly a matter of convenience, although not entirely so. If it uses elements from the same logic family as the rest of the system, the clock generator

will be able to operate from the same supply voltage rails. Normally this will also ensure that its output pulses are compatible with the requirements of the rest of the system in terms of voltage swing, rise and fall times, and so on.

Of course not all systems use a single logic family throughout. Some use two or

NMOS and PMOS devices are provided with internal level translators, so that they may be interfaced with TTL devices directly. Thus a system using some of these devices in conjunction with TTL devices can generally use a TTL clock generator, with no complications.

Some logic families are also partly compatible. For example the logic levels provided by CMOS elements are generally compatible with TTL inputs, although the reverse is not true. So that providing loading considerations are taken into account, a system using both CMOS and say low-power Schottky TTL devices can often be driven directly by a clock generator which

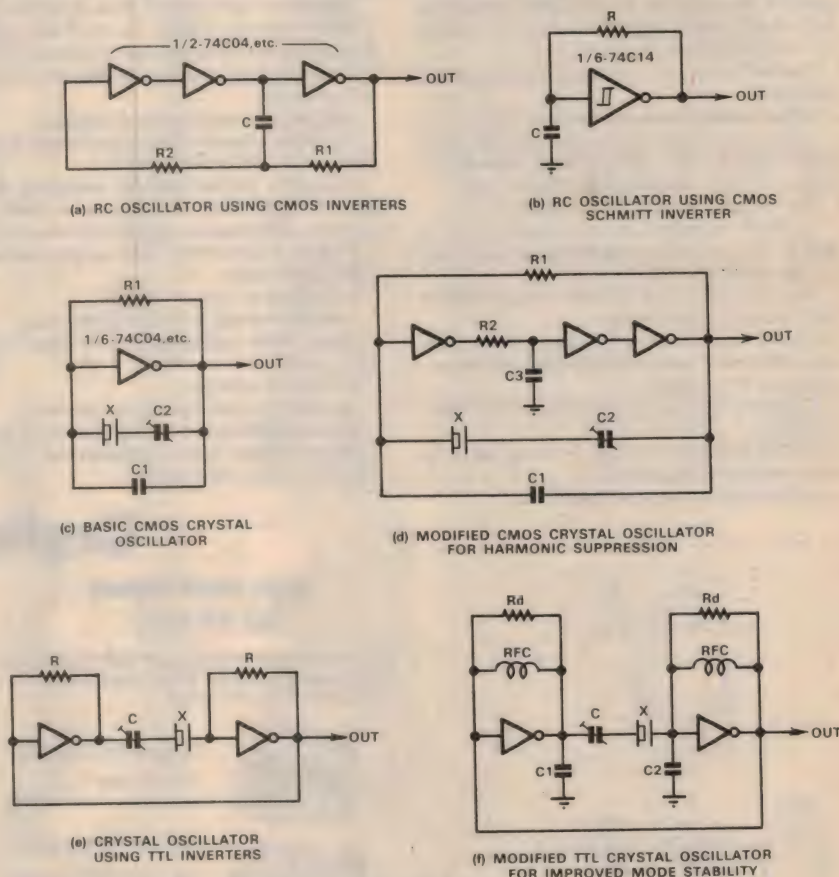


FIG. 1: CLOCK OSCILLATORS

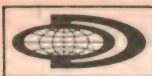
more families, and in these cases it may not be possible to design the clock generator so that its output pulses are directly compatible with all parts of the system. Special "level translator" elements may have to be employed, not just for the clock pulses, but also for any other signals which must pass between devices belonging to different families.

This is not always the case—many

uses CMOS devices, without level translators.

Let us now leave these general considerations and look at some specific clock generator circuits. Some representative circuits are shown in Fig. 1.

A simple RC clock oscillator using CMOS inverter elements is shown in (a). This type of oscillator relies for its operation on the propagation delay through

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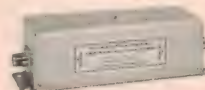
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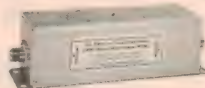
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each inverter—the finite time taken before a change in the input logic level is reflected in a change in the output logic level. Because of this delay, a loop containing an odd number of inverters has a natural tendency to oscillate; in effect, a logic “1” chases itself around the loop.

While a simple loop of inverters will generally oscillate, the frequency of oscillation tends to be rather unpredictable. It also tends to be heavily dependent upon supply voltage and temperature,

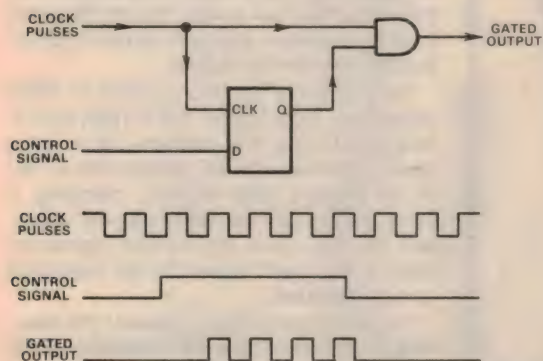
after Otto H. Schmitt, who first described a circuit displaying this type of behaviour in 1938. With a Schmitt trigger, the input threshold V_{TH} where the trigger switches when the input voltage is rising from the low to high logic levels is significantly higher than the threshold level V_{TL} where the trigger switches back again when the input voltage falls from the high to low logic levels. It is the difference between V_{TH} and V_{TL} which is defined as the hysteresis.

For a 74C14 element as shown, the

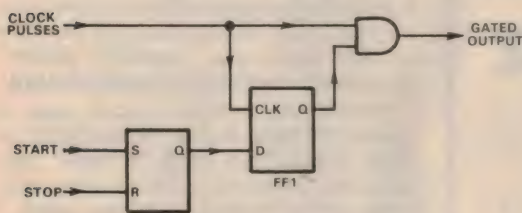
C1 and C2 provided to allow vernier frequency adjustment. Shunt capacitor C1 is used to lower the frequency slightly, while series capacitor C2 is used to increase it slightly.

Resistor R1 is typically quite large, between 1 and 10 megohms.

Although very simple, this oscillator gives very stable output at frequencies where the propagation delay of the inverter is small compared with the period of oscillation. Even for supply voltages as low as 3V this generally allows the circuit

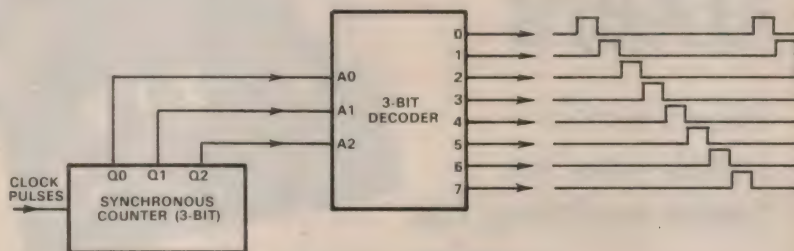


(a) BASIC SYNCHRONISER

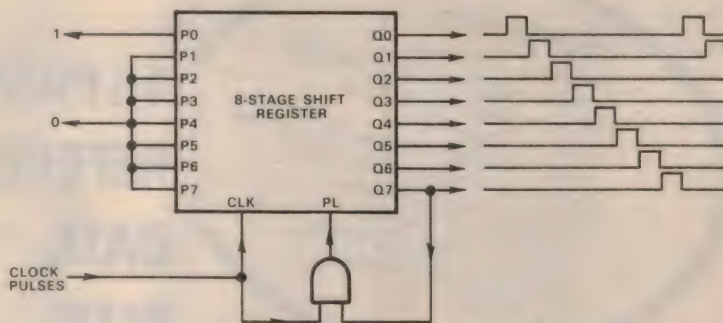


(b) START-STOP SYNCHRONISER

FIG. 2 : PULSE SYNCHRONISERS



(a) COUNTER-DECODER TYPE



(b) SHIFT REGISTER TYPE

FIG. 3 : PULSE DISTRIBUTORS

making such an oscillator rather unsuitable as a clock generator. However if an RC circuit is added as shown, to introduce a delay which is relatively large compared with that of the inverters themselves, the frequency of oscillation becomes both more predictable and more stable.

In fact for the CMOS inverters shown, and if R1 is made equal in value to R2, the frequency of oscillation of the circuit in Fig. 1(a) is quite closely defined by the expression

$$F = 0.559/RC \text{ where } R = R_1 = R_2.$$

The duty cycle of the oscillations produced by this circuit is close to 50%—i.e., it produces a nominal square-wave output. The stability against power supply and temperature variations can be quite good, especially at low frequencies where R and C become relatively large.

Fig. 1(b) shows an even simpler oscillator, again of the RC type but in this case using a single CMOS Schmitt trigger inverter element. Here operation depends upon the fact that a Schmitt trigger element exhibits “hysteresis”: its input switching threshold when the input level is rising is different from that when it is falling, unlike the thresholds of a normal inverter or gate element which are the same in both directions.

Schmitt trigger elements are named

hysteresis is typically equal to about 0.4 of the supply voltage.

If an R-C integrator circuit is connected between the input and output of a Schmitt inverter as shown, the time delay combines with the hysteresis to make the inverter unstable. Its output switches back and forth between the high and low logic levels, producing a squarewave output waveform.

The stability of this simple clock oscillator tends to be quite modest, as the switching thresholds of a CMOS Schmitt element do not remain constant proportions of the supply voltage as the latter is varied. However, for systems which do not require the clock frequency to be particularly stable, one could scarcely find a simpler clock generator.

Even when a system requires the higher frequency stability of a quartz crystal clock generator, this does not necessarily mean that a complex circuit is involved. Fig. 1(c) shows a basic CMOS crystal oscillator, based on a single inverter element, and as you can see it is very straightforward.

Resistor R1 is used to self-bias the inverter so that it operates on the linear part of its transfer characteristic, as an amplifier rather than a switch. To produce oscillations the crystal X is then connected between output and input, with capacitors

of Fig. 1(c) to operate reliably up to about 9MHz.

As with other simple crystal oscillators, there is a tendency for low frequency crystals to oscillate in an overtone mode rather than the desired fundamental. To prevent this, the propagation delay of the oscillation loop can be deliberately increased as shown in Fig. 1(d). Here R2 and C3 have been added to increase the loop delay, while two more inverters have been added to maintain loop gain.

A simple crystal clock oscillator for TTL systems is shown in Fig. 1(e). As you can see it uses two inverter elements, with self-biasing resistors connected across them to produce linear amplification. The two are connected in a loop, completed by crystal X and its series trimmer capacitor C.

The inverters may be either part of a 7404 or similar device, or inverter-connected gates from any of a variety of TTL devices. The biasing resistors R typically have a value of around 470 ohms.

Like the circuit of Fig. 1(c), this simple circuit can allow crystals to oscillate in unwanted modes. It can also display reluctance to oscillate, with crystals of low activity. For these reasons designers sometimes use a modified configuration,

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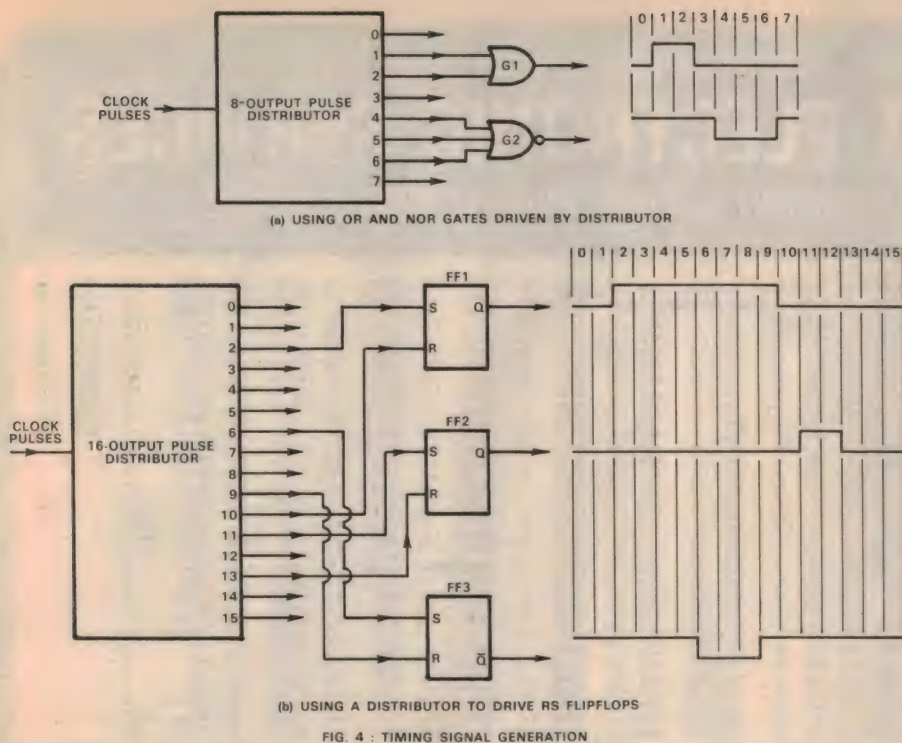


FIG. 4: TIMING SIGNAL GENERATION

shown. While the control signal remains at the logic 0 level, the flipflop remains in its reset state and the gate remains closed. Then when the control signal changes to the logic 1 level (randomly), nothing happens immediately. However, if it is still at the 1 level when the next clock pulse arrives, the FF will be switched to the set state—and synchronously. The diagrams assume that the actual change of state takes place on the negative-going edge of the clock pulse, so that the pulse which performs the switching does not itself pass through the gate. The gate will open just after it has ended, due to propagation delays.

By the time the next clock pulse arrives, however, the AND gate will be fully open, so that this pulse will pass through. And following clock pulses will be passed also, until the control signal falls to the logic 0 level.

When this occurs, the next clock pulse to arrive will pass through the gate, but at the same time it will switch the flipflop to its reset state and hence "close the gate behind itself". By the time another clock pulse arrives, the gate will have closed and no further clock pulses will be passed until a new sequence is initiated by the control signal.

This type of basic synchroniser may be used whenever clock pulses or other timing signals must be gated synchronously in response to a single random input. However, there are occasions where two separate random signals must be used to control the gating—one to open the gate, and the other to close it. For applications of this type the modified synchroniser circuit of Fig. 2(b) may be used.

As you can see, it differs from the basic synchroniser only by the addition of an R-S flipflop. The S and R inputs of this

element are controlled by the two asynchronous control signals, labelled here "start" and "stop". In turn the Q output of the R-S flipflop is used to control the D input of the gate control flipflop FF1.

In effect, the additional flipflop serves to combine the two asynchronous control signals into a single signal, fed to the D input of FF1. Apart from this the circuit operates in exactly the same manner as that of Fig. 2(a).

Another requirement in many digital systems is for various operations to be performed in a sequence—A, then B, then C, and so on.

To arrange such a sequence of operations, it is often necessary to generate a series of single timing pulses or gating signals which are staggered in time. Circuits used to generate such a series of staggered pulses are generally called pulse distributors, and two typical pulse distributor circuits are shown in Fig. 3.

The type shown in (a) consists of a synchronous binary counter driving a decoder. As the counter cycles through its counting sequence, the outputs of the decoder go to the active level in sequence also, producing the desired series of staggered pulses. Each pulse will be one clock period long.

Note that the counter used must be of the synchronous type, with all of its outputs changing state simultaneously. Otherwise the decoder will produce short spurious pulses or "glitches", as the counter outputs pass through transient counts (as we saw in chapter 10).

Although the circuit of Fig. 3(a) is shown with a 3-bit counter and decoder, producing a sequence of 8 staggered pulses, the same idea can be used to generate both shorter and longer sequences. Thus a 2-bit counter and decoder will produce a 4-pulse sequence,

while a 4-bit counter and decoder will produce a 16-pulse sequence.

Similarly although the decoder is shown here having active-high outputs, producing active-high pulses, this is again not fixed. If active-low pulses are required, it is merely necessary to use a decoder with active-low outputs.

The second type of pulse distributor shown in Fig. 3(b) is based on a shift register, with a number of stages equal to the number of staggered pulses required.

This type of circuit operates by first loading a "1" into the first stage of the register, along with "0's" into the remaining stages. Then the 1 is shifted along the register by clock pulses, so that the desired sequence of staggered pulses is produced by the Q outputs of the register flipflops.

The register shown is an 8-stage element, connected to produce an 8-pulse sequence. As you can see parallel input PO is connected to logic 1 level, while the remaining parallel inputs connect to logic 0 level. The parallel load input PL is driven by an AND gate, which in turn is connected so that when Q7 of the register is at logic 1, the register is loaded from the parallel inputs.

Again if the distributor is required to have active-low outputs instead of active-high outputs as shown, this can be achieved by loading a single "0" into the register. To do this PO would be taken to logic 0, and the remaining parallel inputs to logic 1.

As before, this type of distributor may be designed to produce staggered pulse sequences of any desired length. In this case it is merely a matter of providing the appropriate number of stages in the shift register.

Like the counter-type distributor, this type produces output pulses whose length is equal to one clock pulse period.

One of the most important applications of pulse distributors is for generating timing signals—gating signals which must last for a specific number of clock pulse periods, with a certain time relationship to other signals.

There are again two broad ways in which such signals may be generated, using the outputs of a pulse distributor. The two methods are illustrated in Fig. 4.

As you can see, the method shown in (a) involves the use of OR and NOR gates, with their inputs connected to appropriate outputs of the pulse distributor. The number of inputs required by a gate depends upon the number of clock periods which must be spanned by the timing signal to be generated.

Hence gate 1, a 2-input OR gate with its inputs connected to the 1 and 2 outputs of the distributor, will produce an active-high timing signal which will be active for clock periods T1 and T2. Similarly gate 3 with its three inputs connected to distributor outputs 4, 5 and 6 will generate a signal which will be active for clock periods T4, T5 and T6, although in this case the signal will be active-low since G2 is a NOR element.

One disadvantage of this method is that

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a timing signal required to span a large number of clock periods can call for a gate having an inconvenient number of inputs.

This disadvantage is not present in the second method, illustrated in Fig. 4(b). Here R-S flipflops are used to generate the timing signals. The S input of the FF is connected to a suitable distributor output to time the start of the required timing signal, while the R input is connected to a second and later output to time the end of the signal.

Hence FF1, with its S input connected to the distributor 2 output and its R input to the 10 output, generates a signal which is active for clock periods T2-T9 inclusive. Similarly FF2 with its inputs connected to distributor outputs 11 and 13 generates a signal which is active for periods T11 and T12, while FF3 with its inputs connected to distributor outputs 6 and 9 produces a signal active for periods T6-T8 inclusive.

Note that whereas the S input of each flipflop is connected to the distributor output corresponding to the first clock period of the required timing signal, the R input must be connected to the output corresponding to the next clock period after the last period in the required timing signal. This is because the R input triggers the end of the timing signal, not the start of the last clock period.

As with the gating method, both active-high and active-low timing signals may be generated as required. In this case it is merely a matter of taking the signals from either the Q output or Q-bar outputs of the flipflops. The Q output produces an active-high signal, as shown in FF1 and FF2, while the Q-bar output produces an active-low signal as shown in FF3.

A further requirement which crops up from time to time in many digital systems is for pulses to be delayed by a short time, where the time involved may not be equal to an integral number of clock pulses. Some of the common techniques used to produce this type of pulse delay are shown in Fig. 5.

The simplest method is shown in (a). Here a familiar R-C integrator circuit is used to generate the delay, with a Schmitt trigger element following it to restore the pulse to rectangular form. The delay time is a function of both the product of R and C (i.e., the time-constant), and the thresholds of the Schmitt element.

This type of delay circuit is usually only used for relatively short delays, as the Schmitt element hysteresis tends to change the length of the pulse significantly when long delays are used.

Note that in the simple form shown, this circuit inverts the pulse. If the inversion is not required, a further inverter must be used to restore the original polarity.

The other main method of achieving a pulse delay is by using a monostable multivibrator, also called a "one-shot". Elements of this type are available in most logic families; they operate as shown in Fig. 5(b).

As you can see, the device has two

complementary outputs, like a flipflop. Generally there are two trigger inputs provided, one sensitive to a positive-going signal edge, and the other to a negative-going edge.

Basically the monostable has one stable state, corresponding to the "reset" state of a flipflop: with the Q output at logic 0 and the Q-bar output at logic 1. When triggered by an input signal, it switches from this state to the opposite state, but stays in the latter state only for a time determined by the external R and C time-constant. It then switches back automatically to its stable reset state.

Fairly obviously, a single monostable like that shown in Fig. 5(b) is only capable of generating a time delay ending in a level transition. By itself it cannot generate a delayed pulse. If this is required, two monostables must generally be used, connected as shown in Fig. 5(c).

Here the first monostable is used to

as that of the original.

Before we close this chapter, there are two relatively minor aspects of control signal generation which should perhaps be mentioned.

One is the matter of deriving logic signals from mechanical switches, such as those of pushbuttons, keyboard switches, relay contacts and so on.

Generally speaking, this superficially simple operation tends to be complicated because most mechanical switches exhibit a characteristic known as "bounce". Instead of opening and closing cleanly, the switch contacts tend to vibrate rapidly both when they are meeting and when they are parting. This does not cause problems in most analog circuits, but in digital circuits it can produce all sorts of malfunction unless the "bounce" is suppressed in some way.

One approach is not to use mechanical switches at all, replacing them with

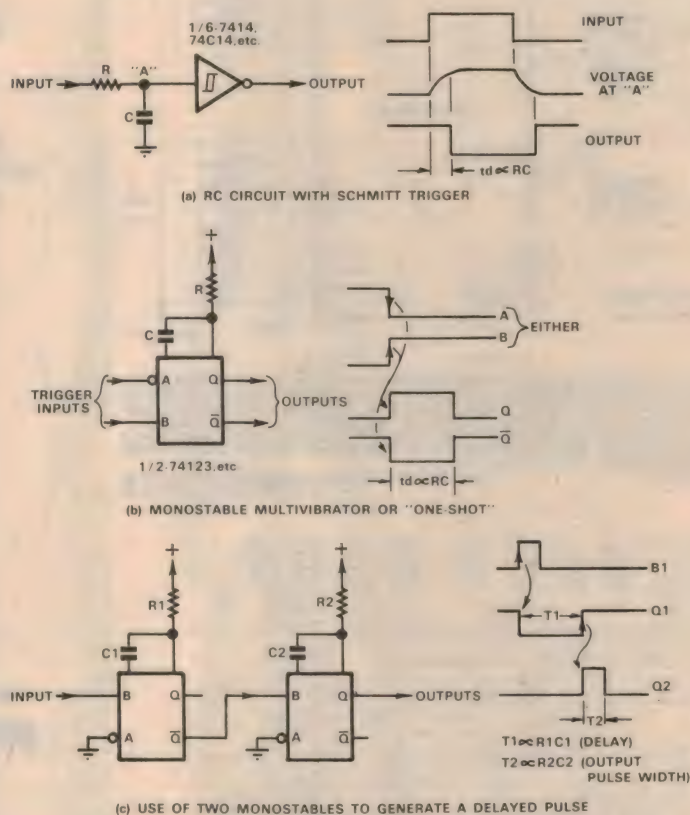


FIG. 5 : DELAY CIRCUITS

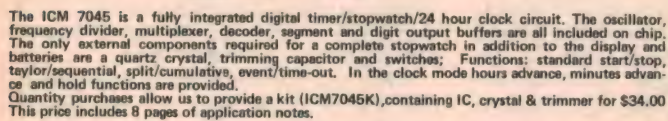
generate the actual delay, with a time determined by R1 and C1. Then by connecting the Q-bar output of this element to the positive-going trigger input of the second element, the end of the delay time is made to trigger the second monostable and generate an output pulse whose length is determined by R2 and C2. So that the first monostable produces the actual delay, while the second generates the new pulse.

By the way, note that neither of the circuits of Fig. 7(a) and (c) actually delay the original pulse. Both generate a second pulse, delayed from the input pulse, whose length is not necessarily the same

equivalent switches which do not exhibit bounce. Examples of the latter are mercury switches, where the switching is performed by liquid mercury metal meeting and parting, and Hall-effect switches where the switching takes place in a solid-state element when a permanent magnet is brought near it or taken away.

While this approach is becoming more practical as time goes on, bounceless switches still tend to be rather more costly than the simple mechanical type. As a result it is often more attractive to use the latter, and use circuits such as those shown in Fig. 6 to "debounce" their output.

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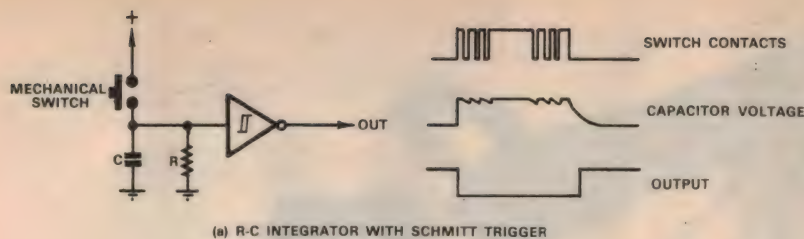
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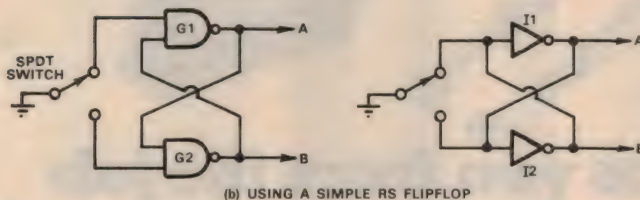
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(a) R-C INTEGRATOR WITH SCHMITT TRIGGER



(b) USING A SIMPLE RS FLIPFLOP

FIG. 6 : DEBOUNCING MECHANICAL SWITCHES

The method shown in (a) uses a capacitor C and resistor R to integrate the contact bounce. When the switch is closed, capacitor C charges up very rapidly as soon as the contacts first touch, taking the input of the Schmitt element well above its positive-going threshold. The R-C timeconstant is such that if the contacts bounce, the capacitor voltage only drops slightly, not enough to fall to the negative-going threshold of the Schmitt element.

Then when the switch is released, the capacitor voltage only drops significantly when the parting contacts have finished bouncing. By the time the voltage drops to the negative-going Schmitt threshold, the bounce has ceased. Thus both turn-on and turn-off bounces are suppressed. The R-C timeconstant is usually made about 20ms, as this is sufficient to suppress the bounce from most switches.

One disadvantage of this circuit is that it introduces a delay when the switch opens. This can cause problems where the switch is used to convey critical timing information. A further disadvantage is that two discrete passive components are required—the resistor and capacitor. These are becoming increasingly costly, both as components and in terms of the labour involved in their assembly.

Because of these problems the more popular way of performing debouncing is by using simple R-S flipflops, as shown

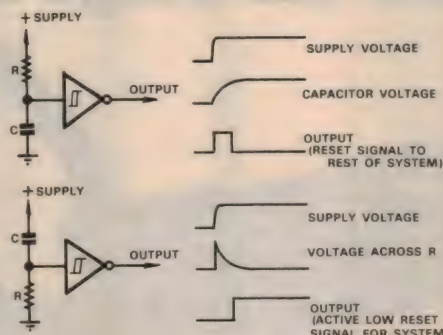


FIG. 7 : POWER-ON RESET CIRCUITS

in Fig.6(b). Here the flipflop effectively integrates the bounce, while at the same time introducing no delay for either closing or opening of the switch. The flipflop may be made up as shown using either a pair of gates or a pair of inverters—or even one of each. Often there are a couple of elements which happen to be "spare" in some of the ICs already used in the system, so that the debouncing is done at virtually no extra cost.

The final matter we should discuss briefly is power-on reset circuits.

Many digital systems must be "initialised" when power is first applied to them, to ensure that all parts of the system begin operating from a predictable and known state. This initialisation is generally performed by generating what is known as a

"power-on reset signal", which is fed throughout the system to force the various circuits and elements into known states.

The power-on reset signal may be generated by circuits of the type illustrated in Fig.7. Both circuits shown use an R-C charging circuit together with a Schmitt trigger element, as you can see.

In the upper circuit, the Schmitt element senses the capacitor voltage, so that when power is first applied the Schmitt element input is held below its threshold while the capacitor charges via R. The output of the element thus goes high. However, once the capacitor charges to the point where its voltage exceeds the Schmitt threshold, the element switches and its output remains low until power is removed from the system. Hence this circuit generates an active-high reset pulse whose length is proportional to the R-C timeconstant.

Where an active-low reset pulse is required by various parts of a system, this can be derived from the active-high signal using one or more inverters. However, if an active-low reset signal is required by all parts of the system, an easier approach is to use the second circuit of Fig.7. Here the R and C are reversed, so that the Schmitt element senses the voltage across R.

As a result, when power is first applied the input of the Schmitt element immediately rises above its threshold, and remains there while the capacitor charges. The output of the Schmitt element thus remains low at switch-on, to generate the reset signal. However, as the capacitor charges the voltage across R decays exponentially, and eventually reaches the negative-going threshold of the Schmitt element. The element then switches, its output going high and remaining in this state until power is removed.

Actually it is not essential to have the Schmitt element in either of the circuits of Fig.7, as neither depends upon hysteresis. A normal inverter element may be used if desired, although the Schmitt element tends to produce a more rectangular output.

In cases where a power-on reset signal is only required for a single logic element, it may be possible to omit an inverter altogether, and simply connect an R-C circuit to the reset pin of the element itself.

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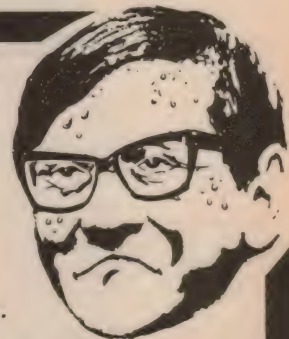
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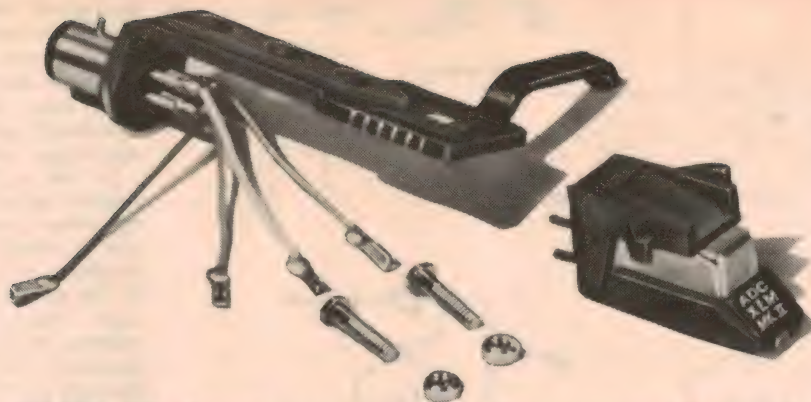
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Reviewed by Julian Russell



Saint-Saens: "most attractive performance"

SAINT-SAENS — Concerto No. 3 in B Flat Minor. Introduction and Rondo Capriccio, and Habanera. Pierre Amoyal (violin) with the New Philharmonic Orchestra conducted by Vernon Hadley. Erato stereo STU 70985 issued here by RCA in its original imported form.

The keynote abroad for the Erato records is elegance. And now that RCA imports them into Australia they arrive just the same as they are sold overseas. Without discussing the music for a moment the whole production is as lovely to handle as it is to look at. The double sleeve for a single disc always carries the most refined illustrations, and even the type choice and lay-out is a pleasure to the eye.

Typical is the Saint-Saens Concerto, the solo part played by a young French violinist hitherto unknown to me, Pierre Amoyal. He has, when he needs it, a big, soulful tone which he uses with musicianly discretion and a very clean technique advertised, in the concerto, by a rather slightly forward placing of his mike. This means that without very careful listening you are likely at times to miss some of the composer's delightful scoring.

His interpretation, though eminently "espressivo", is always kept well distant from facile emotionalism. I'd be inclined to class him as an ideal exponent of Saint-Saens' style.

Those who approve of the composer's unique combination of a classical-romantic manner should be very happy indeed with this reading despite the fact that he is supported by an English Orchestra under an English conductor. Only the annotations are a little windy. They contain no information about Amoyal though I learnt elsewhere that he was a pupil of Heifetz so that his cleanliness of technique is readily explained, especially the faultless intonation of his multiple stopping.

The Intro and Rondo Capriccio allows him to become a little more demonstrative. He attacks the whole work in fine vigorous style in an altogether most attractive performance. Some of his playing is breathlessly fast — Heifetz again — but always of supreme accuracy.

In the Habanera he finds — and sus-

tains — a lovely lilting rhythm as does the orchestra. And in these last two items the balance between him and the orchestra is always satisfactory. He takes the virtuosic passages with supreme ease that never tends to aim at stupefying his audience. While he is still young and probably available without too much bother for an Australian tour his is well worth the attention of the ABC.

By the way, it would be most interesting to hear him in weightier compositions.

★ ★ ★

TCHAIKOVSKY — Violin Concerto in D Major. Serenade Melancolique. Arthur Grumiaux (violin) and the New Philharmonic Orchestra conducted by Jan Krenz. Philips De Luxe Stereo 9500 086.

I admit that I put this disc on my turntable with some misgivings. As a long time admirer of Grumiaux I thought that because the concerto offers so many opportunities to gush he might go to the other extreme and play it deadpan. But the first few bars were enough to remove any of my fears. There is no gush and what emotion there is—and there is plenty in Grumiaux' performance—is always controlled by aristocratic restraint.

When we come to the first movement cadenza, deliberately written for showy virtuosity, Grumiaux perhaps more conspicuously than elsewhere, displays a beautiful choice of varying tempos and classical purity of tone. It would provide a wonderful example to any students of the violin—and perhaps some with considerable reputations as soloists, too.

The slow movement is poetic in every bar but never over-emotionalised. The Finale has Heifetz fire and speeds along as fleetly as can be imagined. The engineering and impeccable balance between soloist and orchestra, and that within the orchestra itself is simply terrific. This record performance has many illustrious competitors but is up among the very best.

The fill is the pleasant Serenade Melancolique which is just as well played and recorded. The orchestra is splendid in both items.

SCHUBERT/MAHLER—Lieder Recital.

Jessye Norman (soprano) with Irwin Gage (piano). Philips Stereo 6500 412.

Black soprano Jessye Norman has a voice most alluring in feminine quality, which is used to perfection without any apparent effort. I shall never forget the thrill I got from her singing in the Sydney Opera House Concert Hall late last year. I have seldom been so moved by everything she sang and this experience was repeated listening to this recording recital.

Indeed I enjoyed the recital under review so much that I played the whole disc right through just to enjoy it without any thought of paying it any critical attention. To her, singing seems as natural as speech, and to use a trite but truthful description, she sings as effortlessly as a bird.

She has a superb sense of phrasing which gives every note just the right weight, and she can change vocal quality from the lightest to the deepest emotional significance when it is needed. But her voice is always under iron control, quite free from any sense of inflation — musical, not economical, of course. The result is the ultimate in beauty and refinement. And she, too, has a splendid accompanist in the person of Irwin Gage.

I have one minor quibble. Since I know all the songs on this disc well I had no need to refer to the accompanying scripts in German and English. But if you should need them you will find them very awkwardly laid out, necessitating turning the page to find some of the translations. But this minor shortcoming apart, this disc is one for the most critical of connoisseurs.

★ ★ ★

MOZART — Piano Concerto in C Major, K246. Concerto in B Flat major, K. 595 Maria Joao Pires (piano) with the Solisti Veneti directed by Claudio Scimone. Erato Stereo STU 70971 issued here by RCA.

Here is another Erato again introducing a brilliant young performer, this time pianist Maria Joao Pires in two Mozart Concertos. The get up is similar to the production reviewed above. Here is no tick-tock Mozart but playing with some of the most subtle inflections I have heard for a long time. It sounds as if she minutely studied the meaning of every bar and delivered it without even the slightest break in the line as a consequence of her explorations.

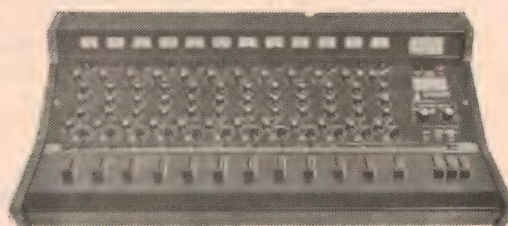
The Solisti Veneti were a perfect choice to support her. The whole combination, soloist and accompaniment use a great many minute though always informative changes of tempo. It goes without saying that the Venetians reflect her every change of mood, however slight. You feel that you can always take Ms

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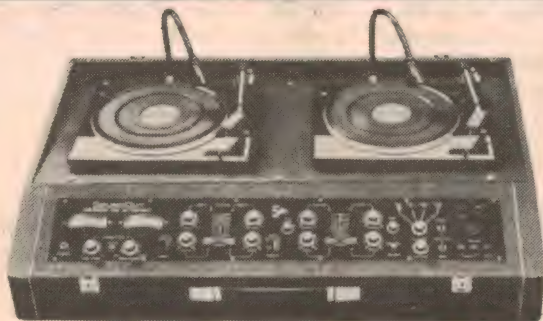


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Pires technique for granted, however difficult the music. One word describes it—perfect.

This is another young artist for the ABC's attention. As to record buyers I can advise them not to miss this disc.

The engineering is spectacularly good in these two lovely concertos about which, alas, I haven't the space to record the many perfections that gave me such pleasure when I played them.

★ ★ ★

HAYDN — Andante and Variations in F Minor.

MOZART — Piano Sonata in D, K.311. Sonata in C. K.330. Fantasia in D Minor K.397. Alicia de Larrocha (piano). Decca Stereo SXLA 6784.

Ms de Larrocha is a refined and graceful player of Haydn and Mozart whom I would recommend with the very greatest enthusiasm had I not played Ms Pires' two Mozart Piano Concertos reviewed above immediately before. This is not to say that Larrocha is not a Mozart player I couldn't listen to for hours. She plays with very great charm indeed but never quite leaves one with the sense of exploratory work that has gone into the Pires performances.

Larrocha also has a tendency to hurry some of the fast movements, not enough to disfigure them in any way but just enough to cause comment. On the other hand she gets a wealth of expression in the slow movements without raising her voice, so to speak.

Another feature to recommend in this disc is the inclusion of the Haydn Variations which is undoubtedly among the best things he ever wrote for the piano. Haydn is, of course, among his other merits, also spoken of because of his seemingly endless ingenuities. You have them in the Variations in their usual abundance. And in this, in terms of her performance, she is never at a loss to communicate every detail of what was in the composer's mind. Another feature is the absolutely lifelike sound all through the whole disc.

★ ★ ★

GRIEG — Peer Gynt Suites Nos. 1 and 2. Four Norwegian Dances (orchestrated by Hans Sitt). English Chamber Orchestra conducted by Raymond Leppard. Philips de Luxe Stereo 9500 106.

The Peer Gynt Suites have been for many years relegated to performance by Palm Court combinations and elementary piano students. They were, of course, composed as incidental music to a very long Ibsen play of the same name. More recently the suites have been fairly often recorded by good orchestras as a kind of dessert to their ordinary fare. The Bournemouth Symphony Orchestra recorded it very well indeed not so long ago.

Now we have a version by the illustrious English Chamber Orchestra, though so rich is its tone in the opening item that you will find it hard to believe that you are listening to a chamber orchestra rather than one of full symphonic size. Yet I could find no mention anywhere of this famous body of musicians having been augmented for the occasion.

It should not be necessary for me to say more than that under Leppard the playing is great. If you want a sample listen to the bloom on the string entry in Anitra's Dance.

The Norwegian Dances on the reverse side make no heavier demands on the listener than the slight ones of Peer Gynt. They are very well scored indeed by Hans Sitt. I am not sure which to recommend at the expense of the other — The English Chamber Orchestra or the Bournemouth Symphony. Both have their great merits and slight blemishes. I can only suggest that you listen to both and decide for yourself. You can't do much harm whichever you choose.

★ ★ ★

RACHMANINOV and GLINKA. Recital of Russian songs sung by Galina Vishnevskaya with Mstislav Rostropovitch at the piano. DGG Stereo 2530 725.

Rachmaninov is nowadays best known by his piano concertos, an occasional performance of a symphony or a symphonic poem, and hardly at all — apart from a few exceptions — for his songs. For that matter song recitals fail to attract the audiences of other days when singers would come on stage clasping a tiny notebook of texts, (at which they glanced occasionally) and a successful concert would end with a few coy encores.

Well there's a whole side of Rachmaninov's songs on this new DGG issue — 5 in all — and 8 by Glinka on the reverse. The singer is Galina Vishnevskaya accompanied on the piano by her husband, probably the greatest cellist playing today.

Vishnevskaya has an indubitably impressive voice, sometimes impaired by a massive vibrato that seems to be endemic in Eastern European trained women singers. It is a very big voice of operatic stature which she uses with a sure sense of pitch and, above all, in a sternly authoritative manner. Occasionally she adds passion to volume too.

And yet, with so much to admire I think I have written before that I seldom find her singing alluring despite the fact that she can tone down to a pianissimo in all registers and still keep its pitch secure. In long, very loud passages she can be quite overwhelming. I therefore advise that before playing this disc you reduce your gain a little from its usual position on your set.

The three best known of the Rachmaninov songs are "Oh, Never Sing to Me Again," "Vocalise" and "Spring

Waters". In the last she is truly rapturous with a brilliant account of the accompaniment by her husband, Mstislav Rostropovitch. I might mention here that all his accompaniments are a delight. In them he displays the same supremely musicianly talent that he does when playing his principal instrument — the cello. In "Sing to Me No More" Vishnevskaya tones it down to recital standards through, in all she sings, any intensity makes her voice pulse.

As a rule I don't find in Glinka's music the response so often expressed by his many admirers. I know that he occupies a position of great importance in Russian music, some musicians even claiming that he is its father. His songs here are certainly tuneful but to me little else. The texts having a drawing-room sentimentality in the manner of the more love lorn type of lieder.

Curiously the copy of these texts that accompany the record are in English, French and German but she sings them in Russian. In all of them you can feel the restraint she imposes on herself to keep them free of operatic proportions. To me the novelty of many of the items are the record's greatest recommendation — and, of course, Rostropovitch's splendid accompaniments.

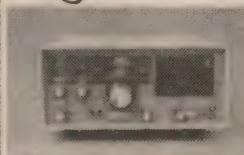
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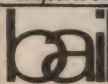
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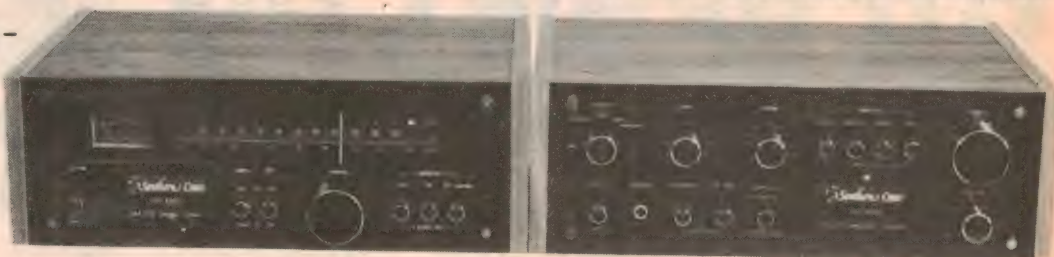
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Lighter Side

Reviews of other recordings

Devotional Records

GOD GAVE THE SONG. The Hawaiians. Stereo Word WST-8715. (From Sacred Productions Aust, 181 Clarence St, Sydney and other capitals.)

From the title of this album and from the cover photograph of The Hawaiians, Mark and Diane Yasuhara, I fully expected Gospel music with a strong south seas flavour. Instead, it turned out to be a concert of quite varied content, from up-tempo popular Gospel, through traditional hymns, to numbers in which both artists go for "operatic" style phrases. The track titles: Bring Back The Springtime — Our Great Saviour — O Love That Will Not Let Me Go — God Gave The Song — Freedom Prayer — Hawaii, Aloha & God Bless America — My Saviour's Love — Creature Praise — Healer Of Broken Hearts — Wonderful Peace.

How will the program appeal to Australian listeners, to whom The Hawaiians are not known? That's a question to which I could find no ready answer. Certainly, if you buy the record expecting a south sea island sound, you'll be disappointed. If you buy expecting any other specific style, the result may be the same. The interest of The Hawaiians, probably reflecting their platform presentation, is in variety. Best you sample a few tracks before you decide. (W.N.W.)

★ ★ ★

MARANATHA 5. Stereo, Maranatha HS-777-25. (From S. John Bacon, 13 Windsor Av, Mount Waverley, 3149)

A sentence from the jacket notes expresses very eloquently the motivation behind this album—and many other Gospel albums—in the modern music format: "Reaching past the obvious rhymes that are so much a part of the protestant vocabulary and bringing a fresh, honest and inspired message of what Jesus can do".

One would gather that the artists responsible for the album are not from a fixed group but came together at the Sunwest and Buddy King Studios in Hollywood, to set down in music a message which they all shared. The names, listed in the credits, would not mean much to most of us but their music is of



a high standard, featuring: guitars, bass, drums, percussion, synthesiser, piano, sax, organ, steel guitar and possibly other instruments for good measure.

The songs, all with a Gospel message in the modern idiom are: Jerusalem — Ain't Gonna Fight It — Maybe — Sidney The Pirate — Falling — Something Happened To You — So Much Love — Bright

And Shining Sun — Golden Ages — Psalm 5.

The quality is excellent, my main problem being to find something different to say about the record. It's trite but true to label it as yet another well produced album from the American popular Gospel Scene. (W.N.W.)

★ ★ ★

WELCOME TO THE FAMILY. Bob Cull. Stereo, Maranatha HS-777/20. From S. John Bacon, 13 Windsor Av, Mount Waverley, 3149.

Endorsed "Re-released by Maranatha's Music", this is the first album by Bob Cull, who not only provides the vocals but is credited also with the composition, arrangement and orchestration.

In his introductory note, Bob Cull emphasises that the songs form a statement of his own convictions, with strong links back to his family and to "my Father, God": Back Where I Started — Here Is All Of Me — Let's Keep Growing — You're A Friend To Me — Welcome To The Family — Someone To Follow — All I Need Is You — Alleluia (instrumental).

Against a varied orchestral background involving, for the most part, a driving beat, Bob Cull's voice and phrasing has something of a C&W twang which may tend to stir likes and dislikes among his listeners. But it's all fairly typical of what is popular on the youth Gospel scene and, if the music appeals, you need have no worry about the recording itself—the quality and surface is well up to standard. (W.N.W.)

Instrumental, Vocal and Humour

KARAJAN CONDUCTS MUSIC OF JOHANN STRAUSS. Berlin Philharmonic Orchestra. HMV stereo OASD 3132.

It is a well-worn cliché to state that much of Strauss's music is hackneyed—for many listeners at least. Here is an album which tended to support the statement in the mind of this reviewer. You may feel differently, of course.

Track titles are: Overture — Die Fledermaus — Annen-Polka — An Der Schönen Blauen Donau — Overture — Der Zigeunerbaron — Tritsh-Tratsch Polka — Kaiserwalzer. (L.D.S.)

★ ★ ★

GRIEG FAVOURITES Decca "The World Of The Great Classics" Series SPA 421

Decca are doing the music lover a great favour in this series bringing as it does, the best loved recordings of the music, regardless of recording age. On this disc there are four of Grieg's best known compositions with the delightful "Peer Gynt" suite and the music to "Sigurd Jorsalfar" on side one, followed

by the "Holberg Suite" and "Cowkeeper's Tune" and "Country Dance" on side two.

The recordings date back to 1957, in one case, but the quality is good except for a uniformly low level of recording that seems to be fairly typical of the series. The orchestras featured are the London Symphony under Oivin Fjeldstad, The Stuttgart Chamber Orchestra under Karl Munchinger and Charles MacKerras conducting the London Proms Symphony; in all a most enjoyable disc. (N.J.M.)

★ ★ ★

THE GREATEST SWING BAND IN THE WORLD, YES INDEED ASTOR Gold NSPL 18493.

The title of this disc sounds like an audacious claim, but on hearing their efforts I would almost be willing to concede that they are right!

Made of some of the best known British swing musicians, the band has tried to recapture some of the music of names like Count Basie, The Andrew Sisters, Woody Herman etc., and has almost succeeded.

The arrangements on side two swing more than on side one but, if you like the titles, the record has the advantage

Reviews in this section are by Neville Williams (W.N.W.), Jamieson Rowe (J.R.), Leo Simpson (L.D.S.), Norman Marks (N.J.M.), David Edwards (D.W.E.) and Greg Swain (G.S.).

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CA4018	2.25	CD4518	1.35	LM340T	2.70	MC1035P	2.90	TB8570	2.90	NSV74	2.90
CA4019	2.25	CD4519	1.35	LM340T	2.70	MC1035P	2.90	TB8570	2.90	NSV74	2.90
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CA4022	2.15	CD4539	1.98	LM340T	2.70	MC1035P	2.90	TB8570	2.90	NSV74	2.90
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In some cases pin for pin substitutes will be supplied.

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7400	48	7401	48	7402	48	7403	48	7404	48	7405	48	7406	1.09	7407	1.09	7408	1.09	7409	48	7410	48	7411	54	7412	1.15	7413	1.15	7414	2.70	7415	1.15	7416	1.10	7417	1.15	7418	48	7419	48	7420	48	7421	48	7422	1.95	7423	.95	7424	.70	7425	.86	7426	.86	7427	.86	7428	.86	7429	.86	7430	.86	7431	.86	7432	.86	7433	.86	7434	.86	7435	.86	7436	.86	7437	.86	7438	.86	7439	.86	7440	.86	7441	.86	7442	.86	7443	.86	7444	.86	7445	.86	7446	.86	7447	.86	7448	.86	7449	.86	7450	.86	7451	.86	7452	.86	7453	.86	7454	.86	7455	.86	7456	.86	7457	.86	7458	.86	7459	.86	7460	.86	7461	.86	7462	.86	7463	.86	7464	.86	7465	.86	7466	.86	7467	.86	7468	.86	7469	.86	7470	.86	7471	.86	7472	.86	7473	.86	7474	.86	7475	.86	7476	.86	7477	.86	7478	.86	7479	.86	7480	.86	7481	.86	7482	.86	7483	.86	7484	.86	7485	.86	7486	.86	7487	.86	7488	.86	7489	.86	7490	.86	7491	.86	7492	.86	7493	.86	7494	.86	7495	.86	7496	.86	7497	.86	7498	.86	7499	.86	7500	.86	7501	.86	7502	.86	7503	.86	7504	.86	7505	.86	7506	.86	7507	.86	7508	.86	7509	.86	7510	.86	7511	.86	7512	.86	7513	.86	7514	.86	7515	.86	7516	.86	7517	.86	7518	.86	7519	.86	7520	.86	7521	.86	7522	.86	7523	.86	7524	.86	7525	.86	7526	.86	7527	.86	7528	.86	7529	.86	7530	.86	7531	.86	7532	.86	7533	.86	7534	.86	7535	.86	7536	.86	7537	.86	7538	.86	7539	.86	7540	.86	7541	.86	7542	.86	7543	.86	7544	.86	7545	.86	7546	.86	7547	.86	7548	.86	7549	.86	7550	.86	7551	.86	7552	.86	7553	.86	7554	.86	7555	.86	7556	.86	7557	.86	7558	.86	7559	.86	7560	.86	7561	.86	7562	.86	7563	.86	7564	.86	7565	.86	7566	.86	7567	.86	7568	.86	7569	.86	7570	.86	7571	.86	7572	.86	7573	.86	7574	.86	7575	.86	7576	.86	7577	.86	7578	.86	7579	.86	7580	.86	7581	.86	7582	.86	7583	.86	7584	.86	7585	.86	7586	.86	7587	.86	7588	.86	7589	.86	7590	.86	7591	.86	7592	.86	7593	.86	7594	.86	7595	.86	7596	.86	7597	.86	7598	.86	7599	.86	7600	.86	7601	.86	7602	.86	7603	.86	7604	.86	7605	.86	7606	.86	7607	.86	7608	.86	7609	.86	7610	.86	7611	.86	7612	.86	7613	.86	7614	.86	7615	.86	7616	.86	7617	.86	7618	.86	7619	.86	7620	.86	7621	.86	7622	.86	7623	.86	7624	.86	7625	.86	7626	.86	7627	.86	7628	.86	7629	.86	7630	.86	7631	.86	7632	.86	7633	.86	7634	.86	7635	.86	7636	.86	7637	.86	7638	.86	7639	.86	7640	.86	7641	.86	7642	.86	7643	.86	7644	.86	7645	.86	7646	.86	7647	.86	7648	.86	7649	.86	7650	.86	7651	.86	7652	.86	7653	.86	7654	.86	7655	.86	7656	.86	7657	.86	7658	.86	7659	.86	7660	.86	7661	.86	7662	.86	7663	.86	7664	.86	7665	.86	7666	.86	7667	.86	7668	.86	7669	.86	7670	.86	7671	.86	7672	.86	7673	.86	7674	.86	7675	.86	7676	.86	7677	.86	7678	.86	7679	.86	7680	.86	7681	.86	7682	.86	7683	.86	7684	.86	7685	.86	7686	.86	7687	.86	7688	.86	7689	.86	7690	.86	7691	.86	7692	.86	7693	.86	7694	.86	7695	.86	7696	.86	7697	.86	7698	.86	7699	.86	7700	.86	7701	.86	7702	.86	7703	.86	7704	.86	7705	.86	7706	.86	7707	.86	7708	.86	7709	.86	7710	.86	7711	.86	7712	.86	7713	.86	7714	.86	7715	.86	7716	.86	7717	.86	7718	.86	7719	.86	7720	.86	7721	.86	7722	.86	7723	.86	7724	.86	7725	.86	7726	.86	7727	.86	7728	.86	7729	.86	7730	.86	7731	.86	7732	.86	7733	.86	7734	.86	7735	.86	7736	.86	7737	.86	7738	.86	7739	.86	7740	.86	7741	.86	7742	.86	7743	.86	7744	.86	7745	.86	7746	.86	7747	.86	7748	.86	7749	.86	7750	.86	7751	.86	7752	.86	7753	.86	7754	.86	7755	.86	7756	.86	7757	.86	7758	.86	7759	.86	7760	.86	7761	.86	7762	.86	7763	.86	7764	.86	7765	.86	7766	.86	7767	.86	7768	.86	7769	.86	7770	.86	7771	.86	7772	.86	7773	.86	7774	.86	7775	.86	7776	.86	7777	.86	7778	.86	7779	.86	7780	.86	7781	.86	7782	.86	7783	.86	7784	.86	7785	.86	7786	.86	7787	.86	7788	.86	7789	.86	7790	.86	7791	.86	7792	.86	7793	.86	7794	.86	7795	.86	7796	.86	7797	.86	7798	.86	7799	.86	7800	.86	7801	.86	7802	.86	7803	.86	7804	.86	7805	.86	7806	.86	7807	.86	7808	.86	7809	.86	7810	.86	7811	.86	7812	.86	7813	.86	7814	.86	7815	.86	7816	.86	7817	.86	7818	.86	7819	.86	7820	.86	7821	.86	7822	.86	7823	.86	7824	.86	7825	.86	7826	.86	7827	.86	7828	.86	7829	.86	7830	.86	7831	.86	7832	.86	7833	.86	7834	.86	7835	.86	7836	.86	7837	.86	7838	.86	7839	.86	7840	.86	7841	.86	7842	.86	7843	.86	7844	.86	7845	.86	7846	.86	7847	.86	7848	.86	7849	.86	7850	.86	7851	.86	7852	.86	7853	.86	7854	.86	7855	.86	7856	.86	7857	.86	7858	.86	7859	.86	7860	.86	7861	.86	7862	.86	7863	.86	7864	.86	7865	.86	7866	.86	7867	.86	7868	.86	7869	.86	7870	.86	7871	.86	7872	.86	7873	.86	7874	.86	7875	.86	7876	.86	7877	.86	7878	.86	7879	.86	7880	.86	7881	.86	7882	.86	7883	.86	7884	.86	7885	.86	7886	.86	7887	.86	7888	.86	7889	.86	7890	.86	7891	.86	7892	.86	7893	.86	7894	.86	7895	.86	7896	.86	7897	.86	7898	.86	7899	.86	7900	.86	7901	.86	7902	.86	7903	.86	7904	.86	7905	.86	7906	.86	7907	.86	7908	.86	7909	.86	7910	.86	7911	.86	7912	.86	7913	.86	7914	.86	7915	.86	7916	.86	7917	.86	7918	.86	7919	.86	7920	.86	7921	.86	7922	.86	7923	.86	7924	.86	7925	.86	7926	.86	7927	.86	7928	.86	7929	.86	7930	.86	7931	.86	7932	.86	7933	.86	7934	.86	7935	.86	7936	.86	7937	.86	7938	.86	7939	.86	7940	.86	7941	.86	7942	.86	7943	.86	7944	.86	7945	.86	7946	.86	7947	.86	7948	.86	7949	.86	7950	.86	7951	.86	7952	.86	7953	.86	7954	.86	7955	.86	7956	.86	7957	.86	7958	.86	7959	.86	7960	.86	7961	.86	7962	.86	7963	.86	7964	.86	7965	.86	7966	.86	7967	.86	7968	.86	7969	.86	7970	.86	7971	.86	7972	.86	7973	.86	7974	.86	7975	.86	7976	.86	7977	.86	7978	.86	7979	.86	7980	.86	7981	.86	7982	.86	7983	.86	7984	.86	7985	.86	7986	.86	7987	.86	7988	.86	7989	.86	7990	.86	7991	.86	7992	.86	7993	.86	7994	.86	7995	.86	7996	.86	7997	.86	7998	.86	7999	.86	8000	.86
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BILL COSBY. My Father Confused Me. Stereo, Capital (EMI) ST11590.

Recorded live at the Las Vegas Hilton, this is Bill Cosby at his funniest and best in front of a responsive audience. His timing—and theirs—is an object lesson to all who aspire to be funny men. And, despite the fact that his act obviously involves the visual as well as the spoken word, it still comes across well on record only.

But, having said that, there are two or three tracks which will not be funny to some listeners, partly because they are so devastatingly true to life: "My Father Confused me"—because of misuse of the name Jesus Christ; "Dudes 'On Dope'", which sends up the antics of its victims; and a dissertation on the gentle art of human flatulence.

So the choice has to be yours. If you're not sensitive about these subjects, you'll rate the album as one of Bill Cosby's funniest; if you are sensitive, you'll find yourself deliberately dodging the potentially offensive tracks.

Technically, the recording itself is excellent. (W.N.W.)

EVITA: a new rock opera

EVITA. Music by Andrew Lloyd Webber; lyrics by Tim Rice. Stereo, 2-record set, Astor MCA2-11003.



As the sleeve sub-title indicates, Evita is an opera—should we add, a rock opera—based on the life story of Eva Peron, the second wife of Argentine Dictator Juan Peron.

Webber and Rice had for some time been seeking a setting and a theme for a spectacular to follow "Jesus Christ, Superstar". They found it in a BBC broadcast, in 1973, devoted to the life of Eva Peron—a woman who emerged from a most obscure and unpromising background to become the most powerful woman in the history of South America. When she died of cancer, at the age of 33, she became an immediate legend in Argentina and, indeed, throughout Latin America.

The 103-minute recording opens quaintly with a scene in a Spanish-speaking movie theatre, where the film grinds to a halt, to be replaced by an announcement that Eva Peron has died. This scene gives way to the state funeral, a massive sonic mix of orchestral and choral sound, and the anguished voices of a huge street crowd. Only one dissenting voice is raised, that of Che, who fails to share the adulation of someone whom he had known earlier as a very ordinary person. From there on, the story flashes back and follows Eva's emergence from a small-town night club to her place alongside the President.

Whether or not you get to see the stage presentation, the MCA double-fold album will do a pretty good job of putting you into the picture, with a generous lift-out brochure containing notes on the cast, a summary of the story parts 1 and 2, and the complete lyrics.

And the music?

While it was playing, a member of the household, who had no idea what was on the turntable, was prompted to ask who wrote that—because it so reminded them of "Superstar". And that indeed is the scale of the score, with the London Philharmonic Orchestra, a rock group and, of course, the character singers.

And, as you might expect, the recording is also on a large scale, intended to be listened to well before the neighbours have gone to bed for the night! The sound quality is clean enough, in its own way, but it's the strident, blaring sound that seems to go with psychedelic lights and rock characterisation.

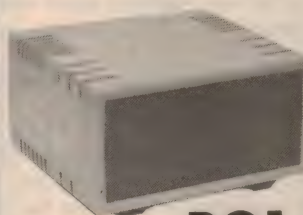
At this point, I guess, the decision is over to you! (W.N.W.)

HERE'S A GOOD CASE FOR HOME CONSTRUCTED EQUIPMENT!

Moulded in self-extinguishing 'Noryl' for safety, these cases are ideal for housing a wide variety of electronic and electrical equipment.

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INSTRUMENT CASES



PC1

The PC1 is an attractive moulded case suitable for power supplies, signal generators, digital clocks, audio amplifiers, radio tuners, etc.

The clamshell construction facilitates assembly and subsequent testing of circuits.

The detachable plastic front panel simplifies the mounting of terminals, controls, meters, displays, etc. Surface texture and colouring lend themselves to silk screen printing or letaset application for those final professional touches.

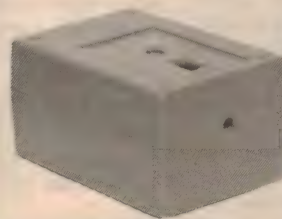
The steel rear panel can act as a heat sink and is prepunched to accept self-locking grommets for mains lead entry.

Moulded into the casing are 3 internal slots which accept 5-3/16" x 2-5/8" printed circuit boards up to 1/16" thick.

The casing incorporates a series of slots which provide adequate ventilation for most applications.

Overall dimensions are 5 1/2" x 5-1/8" x 2 3/4"

Colour: blue-grey, 2-tone.



PC2

The PC2 is a compact case that may be used for battery chargers, battery eliminators, power supplies, digital displays and a wide variety of equipment requiring a small insulated housing.

PC2 has provision for input and output lead entry together with a moulded slot for fitting a slide switch or indicator lamp. In all other respects the case once assembled is completely sealed. A moulded depression in the top cover allows for insertion of a nameplate.

Overall dimensions: 3 1/2" x 2 1/2" x 2".

Colour: blue-grey.

Available from electronic/electrical stores and A & R Soanar branches.

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New Products

AIWA TPR-250: loaded with features

A new 5-band radio cassette recorder just released by AIWA should have a strong appeal to those who may want to listen to, and record, programs from overseas radio stations. Designated as model TPR-250, it covers the normal broadcast band, the international FM band, and provides 3 other bands giving continuous coverage from 1.6 to 28MHz.

In unpacking the TPR-250, one's first reaction, is that it is a complicated piece of machinery—and, in fact, it is. While non-technical members of a household could learn, readily enough, to use the functions they understand, the unit, as a whole, is very much one for the enthusiast.

As a portable, the whole unit can operate normally from five standard flashlight D-cells inserted through a removable cover at the rear. However, it can operate equally well from a car electrical system, assuming the use of an adaptor designed to reduce the voltage to about 7.5V. A third option is to operate it from the normal 240V mains.

Contrary to usual practice, there is no normal off-on switch, the function being performed by the Radio/Tape selector. The unit is "off" with the selector in the "Tape" position and with none of the tape buttons actuated.

To receive "Radio" the switch is clicked into that position and one of the band-select buttons depressed.

Tested in an average suburban location, reception on the broadcast band was good, with adequate gain and selectivity and with no sign of overload on strong local stations. On "Radio", the meter alongside the dial serves as a tuning indicator, while a switch near the tuning knob provides a local/distant facility.

Behaviour on the FM band also was all that could be expected, with a clean (mono) signal from the local stations plus the sound carrier from TV channel 4 in Wollongong, about 40-50 miles distant. A companion switch to the local/distant switch mentioned earlier gives the option of AFC (automatic frequency control) on FM—with the warning (redundant in Australia) that it should be switched out when hunting weak signals.

As indicated earlier, coverage of the short-wave bands is continuous and extensive and this should be an attractive feature to anyone keen on short-wave listening for its own sake, or because they have an interest in an overseas country.

The frequency scales are more open than usual, being printed side-by-side on a roller-blind surface, about 70mm long, which moves past a horizontal cursor. There are two other aids to accurate tuning: a two-speed tuning knob controlled by a fast/slow lever, and a small fine-tune vernier which provides a supplementary plus-0-minus shift.

The TPR-250 has a built-in ferrite antenna for the AM broadcast band and also for SW1 (1.6 to 4.5MHz). A tiltable, telescopic antenna serves the other two short-wave bands and the FM band but there are connection facilities at the back for a 300-ohm FM dipole and also for an external short-wave antenna.

While it would have taken more time than we had available to conduct prolonged listening tests on the various short-wave bands, our impression was that the TPR-250 lost nothing by comparison with other multiband portables that we have handled—but with the distinct advantage of vernier and fine-tune facilities.

Its capabilities in this regard were amply demonstrated by listening to the chatter of various CB operators around 27MHz—a frequency where tuning backlash, drift, noise and lack of gain would have shown up, had they been problem areas. Our one reaction, in the face of all the other design frills, was that the set had not been provided with a

beat oscillator to help resolve CW and SSB stations!

Maybe that would have been asking too much!

In terms of the audio channel also, the TPR-250 has some unusual features: separate slider type bass and treble controls, a rated output of "3800mW maximum", and two loudspeakers a 100 x 150mm woofer and a horn tweeter. An "Ext Spkr" jack is available.

The cassette record/replay section of the TPR-250 is for mono only but facilities otherwise are extensive, with a pause button in addition to the normal controls, plus the facility of using the fast forward and rewind buttons for cue and review respectively. There is a counter, full auto-stop provision, and an automatic replay feature which will initiate play after other procedures without further attention.

And, if the operator is in danger of going to sleep while the cassette system is in use, the same kind of "Sleep" facility which is fitted to bedside clock-radios is fitted to the TPR-250 and will operate on the cassette system as well as on radio!

A built-in electret microphone is fitted but there is provision for an external microphone, with or without a start-stop push button, and an external auxiliary input, with a limited mixing facility.

With AC bias and AC erase, rated signal/noise ratio is 58dB, wow and flutter 0.14% (RMS), and frequency response 50-10000Hz. A slide switch on the side of the unit allows the frequency of the bias oscillator to be varied plus or minus, to help dodge any accidental heterodyne that may result when recording from a radio station.

As with the radio section, we did not put the cassette section through a series of laboratory tests, as might have been done with a fully fledged hifi stereo deck. We sought to react to it as would a typical user:

- Do the controls and facilities operate as claimed?
- Does it record easily and effectively from the radio, as might be required by an ethnic group listener?
- Does the review facility work, as claimed by the manufacturer, allowing segments of speech to be played and replayed as many times as necessary?
- Does a music recording emerge with satisfactory quality in respect to response, distortion, noise and wow?
- Is recording from microphone and auxiliary sources satisfactory?

In all cases, the answer appears to be "yes", suggesting that the TPR-250 should be an attractive proposition for those who have a need for the facilities it offers.

Recommended retail price for the receiver is \$199, complete with mains power cord, demonstration cassette, carrying case, batteries, earphone and earase dummy plug. Further questions can be directed to AIWA Australia Pty Ltd, 14 Gertrude St, Arncliffe, NSW 2205. (W.N.W.)



Toshiba C-2030 48cm Colour Television Receiver

In spite of the high standards already attained, colour television sets continue to improve in picture quality, control facilities and reliability. Projected reliability of the new Toshiba C-2030 48cm model is very high, as it has a three-year warranty on parts and labour. Currently it has the best warranty in the market.

Styling of the Toshiba C-2030 is austere by comparison with many sets, but this helps to make it less obtrusive than sets which have a profusion of knobs and bright metalwork. Most of the controls are hidden behind a door—a good feature in a home with children. The cabinet is finished in teak veneer while the control panel is grey plastic.

Overall dimensions of the set are 655 x 452 x 488mm (W x H x D) and mass is 30kg. The mass is such that it can be lifted by the average man, but it would be more manageable if there were recessed handles in the cabinet sides.

Semiconductor complement is 8 integrated circuits, 35 transistors and 61

The set has a large U-shaped chassis, most of which is occupied by the mother board accommodating modular plug-in PCBs as well as a good deal of the circuitry. There are modules for Picture IF, Sound, Chrominance and Demodulator. These modules are easily removable but access and service to the main mother board requires removal of the chassis.

Channel selection is by means of eight push-buttons on the control panel. Each one of these can be set to select one of the VHF channels from 0 to 11 or one of the UHF channels. When the set is switched on, the channel selected by button one comes up.

Antenna connection is by means of a single 75 ohm coax connector. Presuma-

which is the Contrast knob. All the controls have adequate range and are straightforward to adjust.

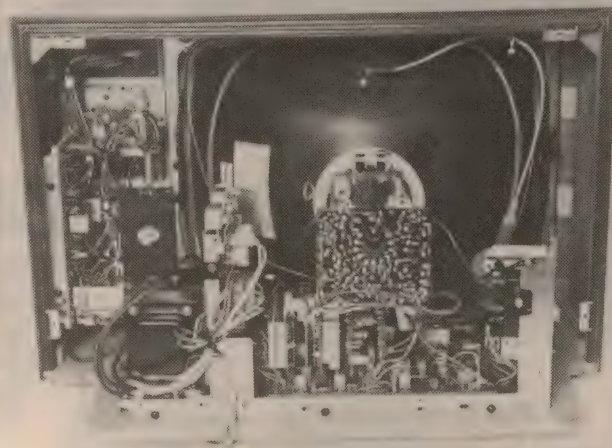
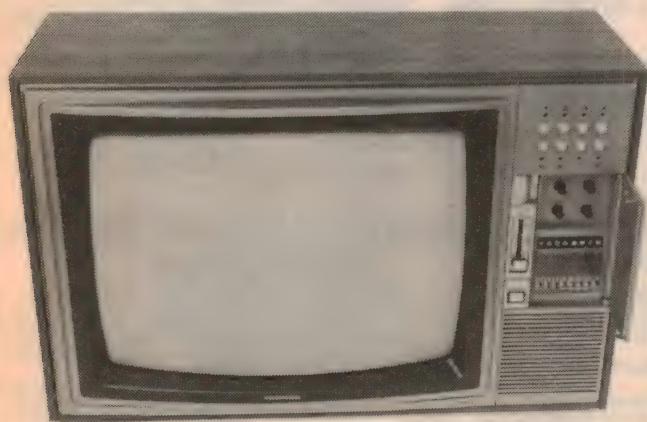
At switch-on, sound is available immediately with the picture after five seconds. Good colour reception was obtained from all Sydney channels and it appeared that sensitivity was on a par with most other sets.

Even though convergence was very good, we found it possible to obtain a slight and worthwhile improvement after going over the adjustments with the aid of a dot and crosshatch pattern generator. As with many sets, there was pronounced overscan horizontally, and we obtained a more satisfactory result by setting the three-way horizontal width connection to its minimum setting. We should remark that these adjustments would normally be done at installation, by the retailer. Having made the adjustments we can state that they are very easy and straightforward.

Overall picture quality is very good. As yet, Toshiba sets do not conform to the Australian "white point" setting of 6500A, but representations are being made to the manufacturers in this regard by the local distributors.

Sound quality was very good considering the modest 10cm loudspeaker and class-A amplifier. A 3.5mm socket disconnects the loudspeaker for headphone listening.

We had access to the service manual



Above is the Toshiba C-2030 with its control compartment door open. At left is chassis.

diodes. The picture tube is the Toshiba "black stripe" 510HJB22PQ 48cm unit with "self-converging" yoke. This latter feature has brought about a reduction in power consumption as well as greatly simplifying convergence adjustments. Power consumption is 97W compared with 120W for the superseded 43cm Toshiba C-812 model reviewed in these pages in May, 1976.

A conventional power transformer and bridge rectifier is employed in the power supply. A new feature is the fail-safe PC board. This monitors the EHT and shuts down the set if the EHT becomes excessive to the point where X-rays may be produced by the picture tube.

bly some sort of splitter will be needed in the future to mix the signals from separate VHF and UHF antennas. The antenna input circuitry conforms to the intent Australian Standard AS3159. This involves the rating of the antenna input coupling capacitors so that even a catastrophic fault in the set does not raise the possibility of electric shock via the antenna cable. A balun adaptor is supplied for connection of 300 ohm ribbon.

Hidden behind the control panel door are the eight preset controls for channel selection together with small knobs for Brightness, Contrast, Colour and Vertical Hold. AFC is engaged by a pull-on switch

at the time of this review and it appears to be comprehensive and well written. It is freely available to all servicemen.

While the foregoing is certainly impressive, the final selling point on Toshiba colour TV receivers is the warranty. As from April 1977, the warranty is three years on all parts including the picture tube and labour costs. This is the best warranty currently available. We hope other manufacturers will soon be able to follow suit.

Further information can be obtained from retailers. Trade enquiries should be directed to the Australian distributors, Toshiba-EMI (Australia) Pty Ltd, 16 Mars Road, Lane Cove, NSW 2066. (L.D.S.)

NEW PRODUCTS

New headset has adjustable mike

A recent addition to the well-known Primo range of microphones is the DH-1005L, a dynamic headset with integral boom microphone. It should be of particular interest to mobile radio operators and radio amateurs.

The DH-1005L is a little more specialised than most of the other products in the Primo range, being designed specifically for "hands off" communication. It combines a padded dynamic headset with a fully adjustable swing-away boom microphone, making a light and comfortable assembly for two-way radio operators, radio amateurs and similar applications.

The headset has two padded earphones for noise-free listening, and is adjustable. It has two 16-ohm inserts which are connected in parallel to present a load of 8 ohms. Power rating is 500mW, with a response of 100-7000Hz.

The microphone boom is attached to the left earphone case. The mounting swivels both to allow convenient positioning of the mike in use, and to allow



it to be swung up out of the way when not in use. The boom is also adjustable radially by about 27mm, to allow for variations in head size. The microphone insert is of the dynamic type, with an impedance of 2k and a rated sensitivity of -74dB.

Mass of the complete headset is 390 grams, making it suitable for protracted use. It is fitted with a 2m cord terminated in separate connectors for the headphones and microphone.

Imported by Paradio Electronics, the DH-1005L is available from Radio Despatch Service, 869 George Street, Sydney. Retail price is \$33.50, including sales tax.

Metal locator

Pictured below, the "Treasure Hunter" metal detector is designed for finding coins and other metal objects. Indication is via an electronic buzzer in the handle. The stem is adjustable up to 35in long, to permit upright operation.

Priced at only \$17.50, the unit is available at Dick Smith Electronics stores (cat. no. X-1062).



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E.F.C.2	75 ohm for colour	Multi	41.70
E.F.C.3/24	75 ohm for colour	Multi	60.64
E.F.C.4/24	75 ohm for colour	Multi	76.30
207/45A	4 & 5A	31.47

CHANNEL MASTER

3110	2 EL Coloray	t2 to 11	27.96
3111	6 EL Super Coloray	Multi	41.98
315	2 EL City VEE	0 to 11	15.68
3615A	9 EL Crossfire	Multi	43.64
3614A	13 EL Crossfire	Multi	54.69
3613A	17 EL Crossfire	Multi	68.17
3612A	21 EL Crossfire	Multi	78.54
3610A	24 EL Crossfire	Multi	99.84
3617A	28 EL Crossfire	Multi	125.73

HILLS FM ANTENNAS

FM1	300 ohm		9.39
FM3	75 ohm		18.27

CHANNEL MASTER FM ANTENNAS

700 FM 8 EL	300 ohm		19.68
200 FM 2 EL	300 ohm		8.31

MATCHMASTER FM ANTENNAS

FMG	300 ohm		11.95
FMG/2	300 ohm		18.30
FMG/6	Fringe area 300 ohm		40.93

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This Top Quality High Performance Unit Features

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\$158.00
Complete with 23 crystals, microphone and mounting bracket.

This de-luxe Transceiver is styled to please the most discriminating buyer—With chromed front escutcheon and woodgrain cabinet.

- Includes mounting bracket for simple installation • Sensitivity—7 uV for 10 dB signal to noise ratio.

THE COBRA 26 \$120.00

The Cobra 26 is called "The Performance Radio" because professional drivers prefer the 26's top rated features and performance. Just check this list: Switchable noise limiting (ANL), RF gain control, Delta Tune, illuminated Power/S meter, adjustable squelch, PA output, detachable dynamic mike and much more.

The Cobra 26 operates at maximum legal power and critical sensitivities. What it really means to you is more enjoyable use of your CB operation. See for yourself why the Cobra 26 is the standard of comparison in the Citizens Band two-way radio industry.

No matter what the conditions, the Cobra 26 punches through loud and clear.

KRACO—AM/SSB TRANSCIVER Model KCB2340 27 Mhzs. Citizen Band. \$255.00 SPECIFICATIONS AND FEATURES:—

- 4 Watts Output (A.M.)
- Delta Tune (A.M.)
- Noise Blanking
- Public Address
- Signal / Power SRF Meter
- 12 Watts Output (SSB) P.E.P.
- Clarifier (SSB)
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ACCESSORIES INCLUDE:— Microphone—Power Lead—

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ALL TYPES OF HARDWARE IN STOCK Wall Brackets, Chimney Mounts, J Brackets, Guy Rings & Guy Wire. Masts from 8ft to 50ft. ETC.

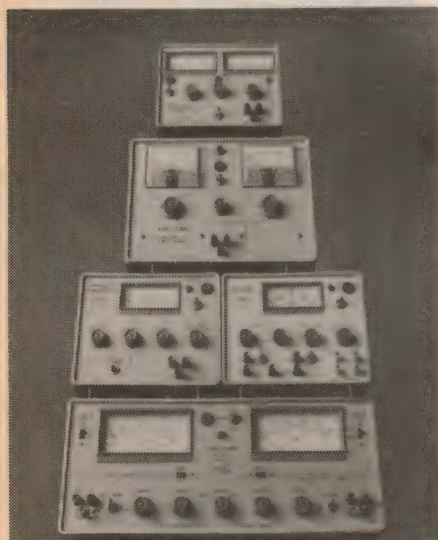
Intercom transmits RF through power wiring



This portable two-channel intercom system requires no interconnecting wires in the conventional sense. Instead, interconnection between units is made via the mains into which the units are plugged to derive power. Information is then transmitted over the mains wiring via an FM modulated RF carrier operating at either 260kHz (CH.A) or 200kHz (CH.B).

The latter feature enables the units to be easily transported around the home or office (or even from home to office), and set up at any convenient location accessible to a power point. Performance of the two sample units submitted was quite satisfactory, and they provided reliable two-way voice communication when tested at various locations within our office building. Further enquiries to Peter Shalley, 554 Pacific Highway, Killara, NSW 2071.

Stabilised power supplies



The range of DC stabilised power supplies available from BWD Electronics includes high current, high voltage, dual and triple range units. Brief specifications of several units are as follows:

- Model BWD 207B: a highly stabilised low impedance supply incorporating foldback overload; constant voltage 10-15V and 20-30V, 0.1% line regulation; constant current, preset 13A (10-15V) and 6.5A (20-30V).
- Model BWD 216A: provides two high voltage, completely isolated, stabilised outputs, together with two unregulated 6.3V AC outputs; high voltage 0-400V and 0-250V continuously variable; constant current 20-200mA (0-400V) and preset 60mA (0-250V)
- Model BWD 246A: has dual output programmable supplies, and front panel

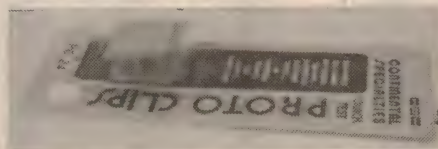
switching for series or parallel operation; constant current 0-10A (0-36V) and 0-2A (0-72V).

- Model BWD 272A: a triple range supply with continuously variable outputs of 0-12.5V (2A), 0-25V (1A), and 0-50V (0.5A). Features include remote sensing, auto parallel and series remote programming.

- Model BWD 275: has dual range and two separate meters to provide simultaneous voltage and current monitoring. Voltage is continuously variable from 0-36V at 2A and 0-72V at 1A.

Other power supplies are also designed and produced by BWD Electronics Pty Ltd, Miles St, Mulgrave, Vic 3170.

IC test clip



Available with 14, 16 or 24 contacts, the Proto-Clip connector is designed to clip onto an integrated circuit to bring leads up from crowded circuit boards for fast signal tracing, signal injection and testing.

The Proto-Clip features self-aligning non-corroding nickel silver contacts and a high-impact plastic construction that eliminates springs and pivots. As an option, the clips are available with attached colour-coded wire cables of various lengths, either with one connector at one end or with a connector at both ends.

Enquiries to General Electronics Services Pty Ltd, 99 Alexander St, Crows Nest, NSW 2065.

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It is different to the earlier model — it is provided with a large scale Ammeter and an internal self-resetting thermal switch for automatic overload protection.

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It will fully charge the average auto battery overnight, without the necessity of selecting a special "boost" position.

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It is made in Australia and designed to comply with Australian standards for continuous operation at 4 Amps.

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It is called the "Husky Mark 4" because it is 4 Amps continuous rating and not the "Husky 6 or 7" because the meter will occasionally and briefly read 6 or 7 Amps under some battery conditions.

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Books & Literature

RSGB handbook

RADIO COMMUNICATION HANDBOOK. Fifth edition, volume 1 (of two volumes). Published by the Radio Society of Great Britain. Stiff covers, 478 pages, 247mm x 180mm, copiously illustrated with diagrams and photographs. Price in Australia, \$10.80.

This publication, popularly referred to as the "RSGB Handbook", has always ranked among the top amateur reference books and this latest edition is no exception.

The decision to split this edition into two volumes is explained in the preface by Pat Hawker, G3VA. It was prompted by a desire to encompass as much as possible of the new technologies and, at the same time, retain as much as is still valid of the old technologies. He cites the example of the modern amateur needing to be familiar with both solid state and thermionic devices, since the latter are still needed for high power stages. The result is a mass of material which cannot be accommodated in one volume.

This volume consists of 10 chapters and a good idea of the book's contents can be gained from the chapter headings. Chapter 1: Principles, 2: Electronic Tubes and Valves, 3: Semiconductors, 4: HF Receivers, 5: VHF and UHF Receivers, 6: HF Transmitters, 7: VHF and UHF Transmitters, 8: Keying and Break-in, 9: Modulation Systems, 10: RTTY.

While it is not practical to summarise each chapter in a review of this size, Chapter 1—Principles—does warrant mention. At a time when there is a tendency to gloss over such fundamentals, on the premise that the modern amateur will probably buy his equipment ready made, it is most gratifying to find that this volume devotes no less than 42 pages to this subject.

And, as this number of pages implies, it is quite comprehensive. The first nine pages are devoted to components; ranging from copper wire to modern integrated circuits and detailing both electrical characteristics and physical form.

From here the discussion turns to the theory of electricity, magnetism, capacitance, and inductance. Then follows signal circuits resonance, practical tuned circuits, radiation, amplification, oscillators, negative feedback, modulation, etc, through to the superhet. These explanations are based on practical circuits and

typical components, and many are thumbnail sketches of subjects which are expanded in subsequent chapters.

By the time the beginner has finished this chapter, he should have more than a smattering of what is involved in electronics generally and communication in particular; enough, hopefully, to whet his appetite for the following chapters.

The two following chapters—valves and semiconductors—are also concerned mainly with basic principles, so that it is not really until chapter 4 that the book gets down to practical designs and circuitry. When it does, though, it makes a thorough job, and from this point on it presents a wealth of information in every chapter.

Summing up: A book no serious amateur can afford to overlook.

Our copy from Technical Book and Magazine Co Pty Ltd, 289 Swanston St, Melbourne, Victoria. (P.G.W.)

IC project guide

111 DIGITAL & LINEAR IC PROJECTS, by Don Tuite. Published 1975 by TAB Books, Blue Ridge Summit, Pa, USA. Stiff paper covers, 130mm x 208mm, illustrated with circuits and diagrams. Price in Australia \$7.25.

With integrated circuits appearing on the market and disappearing in rapid sequence, Don Tuite might rate as a brave man to publish a textbook of projects depending entirely on ICs. He is certainly not unmindful of the problem, however, as evidenced by his preface, which suggests to his American readers how they should persist and proceed if the first supplier approached says "sorry".

In addition, he has sought to write background material into the text, both to enrich the reader's understanding of the general subject and to better equip him to take advantage of other ICs which he may encounter. At the same time, with 111 projects in the book, there is no space to spare on mechanical aspects; he presents the circuits, typically as taken from manufacturers' application notes, a small amount of theoretical background, and that is that.

Chapter 1 is a general introduction to linear ICs. Then follow chapters on Audio Amplifiers, Oscillators and Signal Generators, RF-IF Amplifiers and Detectors, Regulators and Power Supplies, Measuring Equipment, Filters, Special Purpose

ICs and Applications, Analog Computation. To round out the book, there is an appendix, a glossary, index for the text and an index for ICs.

Not surprisingly, the IC projects are more ambitious than projects in similar books using discrete components and they would be a bit heavy for beginners. However, those anxious to graduate from simpler things to ICs should find the book quite helpful.

Our copy came from Technical Book Co, 295 Swanston St, Melbourne, 3000.

Practical audio

AUDIO AMPLIFIERS FOR THE HOME CONSTRUCTOR by Ian R. Sinclair. Published by Fountain Press, Watford, England. Stiff paper covers, 107pp 137mm x 215mm, illustrated by circuits and diagrams. Price in Australia \$6.50.

No single book of modest size could possibly hope to transform a reader into an expert on the subject of audio amplifiers, but a good text certainly can add materially to his/her store of knowledge.

In this book the author, Ian Sinclair, devotes the first chapter to fundamentals, beginning with basic concepts of electrical current and resistance, leading on to AC waveforms and thence into audio signals, amplification, distortion and frequency response. Without reading every word, it appears to be well and systematically presented.

Chapter 2 discusses single stage amplifiers, not as an end in themselves but as building blocks of larger systems. Operating parameters, bias, input and output impedances, gain, etc, are explained. Two-stage amplifiers are covered in a similar manner in Chapter 3.

The following chapters are devoted to power amplifier stages: concepts (ch.4), low power amplifiers (ch.5) and higher power amplifiers (ch.6). The final chapter deals with tone control and equalising circuits.

Because the author is concerned with circuit principles, he restricts discussion completely to discrete devices, leaving ICs to look after themselves. No, the book won't make anybody an instant expert but one thing is certain: anyone who assimilates what Ian Sinclair has set out here will be a fair way along the road to understanding this interesting subject.

Our copy came from Lothian Publishing Co Pty Ltd, 4-12 Tattersall's Lane, Melbourne 3000. (W.N.W.)

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A.R.R.L. Electronics Data Book	\$7.20
Reference Data for Radio Engineers (New Edition) I.T.T.	\$37.50
Radio Handbook (William I. Orr) 20th Edition	\$24.40
World Radio TV Handbook 1977	\$11.95
Weather Satellite Handbook (Dr. R.E. Taggart)	\$4.95
Radio Amateur Callbook Magazine (U.S. Listings) (55th Anniversary Edition for use 1977)	\$18.50

New Books:

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CMOS Cookbook (Lancaster) 1st Edition, 1977	\$14.20
Active Filter Cookbook (Lancaster)	\$19.00
FM From Antenna to Audio (Leonard Feldman)	\$7.00
Transistor Substitution Handbook	\$5.75
International Transistor Selector (T.D. Towers)	\$6.95
Shortwave Listener's Guide (H. Charles Woodruff)	\$5.60
Intermodulation and Harmonic Distortion Handbook (Howard M. Tremaine)	\$5.45
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Questions & Answers About CB Operations (Leo G. Sands)	\$5.30
CB Radio Operator's Guide (2nd Edition) (Robert M. Brown & Paul L. Donweiler)	\$8.50
From CB to Ham Beginner (J.S. Stanley)	\$6.95
CBer's Handbook of Simple Hobby Projects—114 Tested Performance Improvers (Robert M. Brown)	\$5.50
Practical CB Radio Troubleshooting & Repair (David F. Norman)	\$8.50
The Best Book on CB—Includes all 40 Channels & 1977 Regulations (Evan Herbert)	\$6.25
CB Bible—The Complete Guide to Citizens Band 2-Way Radio	\$6.95

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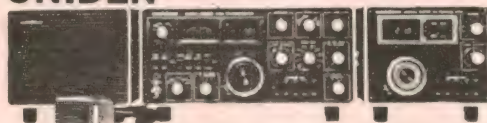


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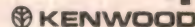
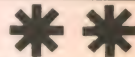
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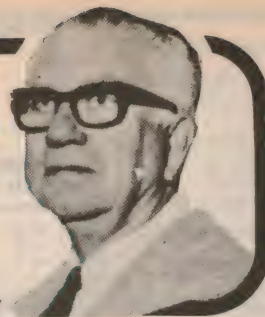
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The Amateur Bands

by Pierce Healy, VK2APQ



WIA Federal Convention

The Wireless Institute of Australia, the oldest national amateur radio society in the world, is the only body recognised by government authorities as representing the entire amateur radio service in Australia. Policies of the WIA are formulated and adopted at annual federal conventions.

The federal convention of the WIA was held in Melbourne during the Anzac weekend 1977. A wide range of matters relating to current and proposed amateur activity was discussed. The convention was attended by federal councillors representing each of the seven divisions, and members of federal executive.

Federal executive supplied details of the items discussed.

After very considerable discussion by a working group, and later by all delegates, the following position paper relating to citizen band operation was adopted.

"1 That the amateur radio service is accurately defined by the International Telecommunications Union.

2. That 'CB' type operation by non-technically qualified operators is entirely different in character from the amateur radio service.

3. That a 'CB' type service could not be regarded as part of the amateur radio service.

4. That it is highly undesirable and totally unacceptable to combine 'CB' and amateur radio on the same frequency band.

5. That all radio services should be subject to regulation and that regulations should be enforced. Unlawful use of spectrum space, particularly that allocated to legitimate services, should be subject to prosecution.

6. That without expressing judgement on a 'CB' service as such, other established services should not be required to give up frequency allocations for such a service.

7. That the use of frequency by a 'CB' type service should not be in derogation of the ITU convention and regulations (eg, an avenue for international communications).

8. That the introduction of a 'CB' type service must not in any manner result or contribute towards the reduction or unwarranted variation of conditions applicable to the amateur radio service or which would result in the imposition of conditions less advantageous to the amateur in respect of present technical standards."

Another subject was the "Arnold Report" this dealt with proposals for restructuring the WIA. (see June 1976 issue of these notes).

In not adopting the report the federal council noted that the organisational proposals were not considered to be appropriate at this stage, but that the other recommendations were being actively considered by the executive and in a number of cases had already been adopted and implemented, namely:—

1. News tapes: Communication has improved between the WIA executive office and members by the use of weekly broadcast tapes for propagating up-to-date information. Not only are these tapes being used

for divisional broadcasts but are also used as part of broadcasting stations' amateur radio news programs (in Victoria 3CR and 3HA make use of tapes supplied by the Victorian division.)

2. WIANEWS: Stop press information to members and clubs has been stepped up via WIANEWS and inserts in the Institute magazine Amateur Radio. This regular feature aims to cover relevant items of news from within Australia and overseas.

3. Call book: The Institute has been successful in negotiating a new contract with the P and T Department for the publication of the Australian amateur station call books over the next ten years. These will use the institute's EDP (computer) records.

Membership drive: It is intended to continue the (8000) campaign implemented during 1976, to increase Institute membership.

RADIO CLUB DIRECTORY

An invitation is extended to radio clubs to supply details for a Radio Club Directory in the 1977 Year Book.

Only details received between now and 1st August, 1977, will be included.

Please give details in the following format.

Club name:—

Club call sign:—

Meeting place:—

Day and time:—

Affiliation:—

Net frequency:—

Contact:—

In past years this facility has been the means of publicising your club and assisting visitors and prospective members in your area.

Do not delay—write now.

WIA Publications: The feasibility of publishing an amateur radio year book for sale to the public through normal commercial outlets is being investigated. The present procedures for publishing and distributing 'Amateur Radio' have been revised and are considered to be satisfactory at present.

P. and T. Department discussions: The relationship between the WIA and the P and T Department continue to be close and cordial. During the past year constructive discussions have been held on such matters as novice licensing; the call book; WARC 79; CB; repeater licensing conditions; amateur licence examinations.

Federal office: Executive office procedures have been reviewed and streamlined wherever possible to achieve the maximum efficiency.

Financial: The convention passed a motion that the federal element of the 1978 membership subscriptions be determined not later than 31st August, 1977. Another motion was passed—that for funding WARC 79 expenses a levy be imposed on each division at the rate of \$2.00 per member at the time of 1978 subscription invoicing. Such a sum to be paid prior to 31st March, 1978 by the divisions.

Reports from officers responsible for various Institute activities were also discussed. Two of these were—

Project Australis: The report of the chairman of the WIA Project Australis group, David Hull, VK3ZDH, dealt with Australian participation in the AMSAT program. The report was received and adopted. It highlighted several problems. One of the more important was the fact that because of other commitments he wished to step down from the role as Australis chairman in order to concentrate on the command station role.

He noted that a number of very capable interstate amateurs had, over the years, offered help with the construction of hardware, etc., but this could not be taken up because of co-ordination difficulties. Further action relating to this was left in the hands of the executive.

WICEN: The federal Wireless Institute Civil Emergency Net co-ordinators' annual report highlighted a number of problems. It seemed many members were apprehensive about joining WICEN but, in discussions, it emerged that the procedures to be learned were simple, minimal and common sense. Nobody need have any fears of tedious learning before being accepted into WICEN. Message handling procedures were easy to assimilate meaning that a disciplined back-up service, such as that offered by amateur radio, was more likely to be accepted and used by State Emergency Services.

An undisciplined rabble involved with radio communications was something that everybody feared.

It was agreed to look into the feasibility of holding a WICEN co-ordinators' meeting in the near future.

IARU NEWS: One of the four directors of the Region III Association of the International Amateur Radio Union, and liaison officer of the WIA, Michael Owen, VK3KI gave a resume of IARU activities in preparation for WARC 79. He said that amateur radio is now entering the pre-WARC 79 period of activities to detect and define the areas of frequency clashes. The IARU had accepted the role of co-ordinating and assisting societies towards influencing their administrations. In the larger countries WARC 79 work was well advanced and their experience would be valuable in identifying problem areas. Much work and many difficulties lay ahead.

The problems expected in connection with amateur geostationary satellites was referred to. An IARU international working group meeting was scheduled for June, 1977 in England, which he would be attending. This group would be preparing material at different levels for use by IARU societies in their approaches to their administrations for WARC 79.

In considering WARC 79 some preliminary assessments were made relating to air fares to Geneva, accommodation expenses, etc.

It was most pleasing to note the very large voluntary contribution being made towards the Region III Association by the Japanese national society the JARL. Tribute was also paid to the work of the association's secretary, David Rankin, 9V1RH/VK3QV.

The federal president WIA, Dr David Wardlaw, VK3ADW advised that very little feedback had derived from the last APG meeting at which frequency requirements for all services had been submitted.

The third Region III Association convention will be held during 1978 at Bangkok. The WIA should consider representation by two delegates for various reasons, particularly those relating to WARC 79, the following year.

Various problems with the IARU Region III Association's constitution also require to be tackled.

Radio clubs and other organisations, as well as individual amateur operators, are cordially invited to submit news and notes of their activities for inclusion in these columns. Photographs will be published when of sufficient general interest, and where space permits. All material should be sent to Pierce Healy at 69 Taylor Street, Bankstown 2200.

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AMATEUR BANDS

NOVICE LICENCE EXAMINATIONS

The Radio Branch, Postmaster General's Department advises that the novice licence examination scheduled for next November will now be held on the 25th October, 1977. This arrangement applies to 1977 only. Closing date for applications for this examination is the 16th September, 1977.

During 1978 novice licence examinations will be held on the third Tuesday of May and November.

At the last examination 200 candidates sat for the novice licence examination held at the Macquarie University.

RADIO CLUB NEWS

SOUTH WEST ZONE CONVENTION: The 25th SWZC will held on Saturday 1st October and Sunday 2nd October, 1977. The venue will be Griffith, NSW, in the Ex Servicemen's Oval Pavilion. A wide range of events is being organised including an anniversary dinner on Saturday evening.

Accommodation is expected to be scarce. However, the organising committee will arrange for bookings prior to 30th August, 1977. Send \$10 deposit together with your requirements to the Secretary, South West Zone Convention, PO Box 854, Griffith NSW 2680.

More details in later notes.

RADIO AMATEUR OLD TIMERS' CLUB: Formed in Melbourne three years ago by Bob Cunningham, VK3ML. The original concept was a small committee to organise a dinner for old timers who had been licensed for 50 years or more. Because there were so few with that qualification it was reduced to 40 years and subsequently to 25 years and over.

Membership is open to interstate and overseas amateurs who have been licensed for 25 years or more.

Currently the officers of RAOTC are:— Bob Cunningham, VK3ML—Inaugural president (retired) now Ad Hoc member; Alan Butement, VK3AD—President and chairman; Harry Cliff, VK3HC—Secretary/treasurer; Max Hull, VK3ZS Minute secretary; John Tutton, VK3ZC; Les Gough, VK3ZH; Stan Dixon, VK3TE; Dick Pope, VK3ARP Committee members.

Further details from the above at their call book address.

MOORABBIN & DISTRICT RADIO CLUB: There are 25 persons attending the regular Tuesday night novice and AOCB classes conducted at the club by Morry Evered, VK3AVO and Fred House, VK3ARK. Inquiries from prospective students are welcome.

The May 1977 issue of the club magazine "APC" contained some points on 70cm FM activity in Melbourne. It is suggested that the national simplex channel 439MHz be used in preference to 435MHz.

A 70 cm repeater in Melbourne has an input frequency of 433.525MHz and an output of 438.525MHz and can be worked by mobiles in the eastern suburbs.

The repeater, VK3RAD, is fully solid state and has an output of approximately 20W to a single antenna

using a diplexer. Time-out is two minutes.

Equipment used by operators is a mixture of commercial transceivers, converted two metre gear and home built units. Antennas for mobile use are quarter wave whips or high gain co-linears. Base stations also use yagis.

GEELONG AMATEUR RADIO & TV CLUB: The annual general meeting, on the 29th April, 1977, elected the following office bearers:— President — Dick Forester, VK3VU; Vice-president — Peter James, VK3ZOS; Secretary — David Mann, VK3ZMZ; Treasurer — Harold Selman — VK3CM; Public relations officer — Alan Bradley; VK3LW; Technical officer — Dennis Haustorfer, VK3ZKH; Property officer; Peter Simons, VK3VY; Newsletter editor — Arie Groen, VK3AMZ.

The reports from outgoing officers indicated that the club had had a very active year in both educational and social areas, and was financially sound.

EASTERN & MOUNTAIN DISTRICT RADIO CLUB: General meetings are held in the Willis Room of the library and branch meetings in the Coffee Shop of the Nunawading Civic Centre, Maroondah Highway, Nunawading, commencing at 8.00pm.

Dates for general meetings are — 5th August, 2nd September, 7th October, 4th November, 2nd December. Branch meetings — 29th July, 26th August, 30th September, 25th November. Visitors and intending members welcome.

ST. GEORGE AMATEUR RADIO SOCIETY: The annual general meeting was held at the Civil Defence Headquarters, Bexley, on Wednesday evening 4th May, 1977.

The president Noel Spratt, VK2BSN was re-elected un-opposed. Other officers elected by ballot were:— Vice-president — Allan Walker, VK2ZEW; Secretary and QSL officer — Alan Pettiford, VK2BAX; Treasurer — Keith Connolly, VK2NDC; Committeeman — Fred Millington, VK2ZFF; Disposals officer — Bill Shakespeare, VK2AGF; Education officer — John Wightman, VK2YBY; WIA liaison officer — Chris Jones, VK2ZDD.

Due to the rapidly growing membership (124) the present meeting venue is now too small. Negotiations

are almost complete for meetings to be held in the assembly hall, Kingsgove Primary School. Education classes will still be held at the Civil Defence Headquarters, Bexley.

The Society's repeater, VK2RLE, (channel 4) is working extremely well, serving a very wide area. It is expected that this area will be extended with the installation of a new antenna and filter system. For further details contact Alan Pettiford, VK2BAX on phone 533 4515, or 70 0661 during business hours.

ILLAWARRA AMATEUR RADIO SOCIETY: The first Earth-Moon-Earth contact between VK2AMW at Dapto, NSW and a station on the African continent took place on the 23rd May, 1977. The station was ZE5JJ in Salisbury, Rhodesia. This was the first attempt at making contact since a new 9.75 metre dish antenna at ZE5JJ had been put into operation. Signals received at VK2AMW were a maximum of 7dB above noise.

This is the first known UHF contact between Australia and Africa. It also means that confirmed contacts have been made with stations on all continents outside Australia on 432MHz. This took approximately 7½ years EME work.

Tests were carried out with K4VOW on the 30th May, 1977. Signals were heard but were not strong enough to make contact. At the time, VK2AMW echoes were quite good at 9dB maximum above the noise.

CENTRAL COAST AMATEUR RADIO CLUB: The club has undertaken a novice licence course to prepare prospective amateurs for the examination on the 25th October, 1977.

Classes in radio theory, regulations and Morse will be held in the Kariong club rooms each Wednesday, between 7.30pm and 9.00pm.

There will be a nominal charge to cover the cost of materials supplied. Anybody is eligible to take the course; there is no age limit and no proof of previous academic expertise is required.

Write to the Secretary, PO Box 238, Gosford, NSW 2250, for further details.

The NSW management committee of the Youth Radio Service has presented the Radio Instructors Certificate to the Central Coast YRS supervisor Gor-

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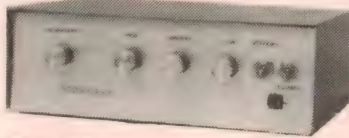
To achieve this aim, why not undertake one of the Courses conducted by the Wireless Institute of Australia? Established in 1910 to further the interests of Amateur Radio, the Institute is well qualified to assist you to your goal. Correspondence Courses are available at any time. Personal classes commence in February each year.

For further information write to

**THE COURSE SUPERVISOR,
W.I.A.
14 ATCHISON STREET,
CROWS NEST, N.S.W. 2065**

A.C.E.**RADIO****MUSICOLOUR**

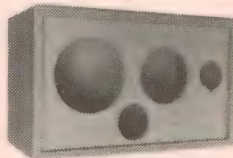
For the disco, light show, party, nites, or just relaxing... enjoy your records and tapes more with the new magical Musicolour Organ. Simple to connect to the home stereo or P.A. system. 3 channels, 1500 watts max. load each.

**\$75.00**

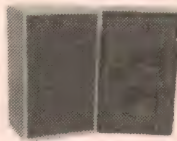
Fully constructed, ready to operate
Complete kit of top quality parts and instructions for the models 11 or 111 **\$55.00**
P.P. NSW **\$3.50**, interstate **\$5.50**.

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DO IT YOURSELF. BIG SAVINGS**

Extra easy to finish as the top, bottom, each side and back are factory assembled and the baffle board is pre-cut out. Veneered pineboard. Teak or walnut. Supplied with inner-board acoustic lining and grille cloth. 3-4IL **\$55.00** pair. Mv-50 **\$69.95** pair.
Can despatch rail, road or airfreight for.

**PLAYMASTER 3-4IL Loudspeaker System.**

30 watts of excellent hi-fi. Beautiful teak or walnut veneered cabinets. Driven by the mighty 8-30 Woofer. Smooth 6-25 mid-range. Super sensitive Philips AD0160/T8 Tweeter. Specially designed frequency divider network. **\$98.00** each or **\$190.00** pair. Weight 40Kg. Despatch Aust. wide.

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All complete with cross-over components, speaker grille cloth, innerbond and tubes.

3-45L	3-4IL	MV-50
Magnavox 8-30 Bass	8-30 Bass	Magnavox 10/40 Bass
Magnavox 6J Midrange	Magnavox 6-25 Midrange	6-25 Midrange
Philips AD0160/T8	AD0160/T8	2x Magnavox XJ3
Dome Tweeter	Tweeter	Dometweeters
Weight 4.5 Kg.	Wt 5Kg	Wt 5.5 Kg.
\$57.00 each Kit.	\$67.00 ea. Kit	\$78.00 ea. Kit

Despatch by post, rail, road, sea, or airfreight.

P.A. PROJECTION FLARES

Dimensions, 18" dia. x 14" complete with mt. bracket. Weatherproof 8" heavy duty speakers.



10 watts RMS 15 ohms **\$24.95**
20 watts RMS 8 ohms **\$28.95**

**COAX CONNECTORS
AND CABLE**

1 Metre 58U Coax cable with PL 259 Plug on each end **\$2.75**.
58U Coax Cable, Cap. 28.5. Conductor Dia. 0.4mm. Dia. or 4.9mm. 30c per metre.
T Way. 2 Female to PL-259 plug **\$2.75**.
Double Female Joiner **90c**. Double Male Joiner **1.20**. Lightning Filter and Arrestor **\$3.75**. Dummy load with 5 watt lamp **\$2.75**.
PL-259 Plug 95c. Chassis socket. 85c. Add P&P.

SWR.300-S.W.R. METER

Compact and rugged unit for CB and amateur radio antenna installations—also for field strength measurements (mobile or base)—V.S.W.R.: 1:1 70 10:1 Power: 0-20 Watt —F.S. Scale: 0-10 **\$14.50** P.P. **\$1.00**

**27 MHz Hi Gain Ringrod
Base Station Antenna**

Fully collapsible, no tools or ground plane required. 6.875 metres. High, 52 ohm feed point, wide band, gain 3dB. SWR. 1.5 or better. **\$56.95** F.O.R.
7 strand stainless steel aerial guy wire. 600 LBS. B-S Polythene covered. 40c per metre.

MICROPHONE STAND

Professional quality. 6ft floor model, retractable to 3ft. Heavyweight cast iron base **\$25.00**. Freight extra.

SPEAKER COVER PLATES

Heavy Duty Plastic Diffuses for Ceiling or wall mounting. (Also suitable for exhaust fans) 10" dia. for 8" Speaker, 8 1/2" dia. for 6" Speaker—White only. 10" sq. for 8" speaker. Brown or white. **\$3.50** ea. P&P 80c.

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Designed by E.A. to operate your C-B Rig off 240VAC. 50Hz Regulated 13.6VDC. 1.5 Amp Power Supply. Easy 1.5 amp power supply. Easy Home Constructor Project Complete Kit of parts with instructions **\$16.50**. P&P **\$2.50**.

**FM WIRELESS
MICROPHONE**

Cardioid Electret condenser type. Transmitting freq. range. 88-106MHz. freq. dev. + 75KHz. Field S. 50uV/MAT 50ft. **\$24.95** p.p. 80c

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30CM (12") 8 AND 15OHMS VC DIA. 5.1CM BIG 3KG MAGNET. FREQ. 40-7000 Hz FOR BASS GUITAR. ORGAN GUITAR WEIGHT 4.5 KG. **\$49.00**. P.P. **\$3.50**

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RECHARGEABLE BATTERIES**

Type A. \$2.50EA. 4 for **\$9.00**
Type C. \$4.10EA. 4 for **\$14.75**
Type D. \$5.00EA. 4 for **\$18.00**
P&P. \$1.00 | State \$1.75
SANYO NICAD BATTERY CHARGER **\$25.95**. P&P **\$1.60**

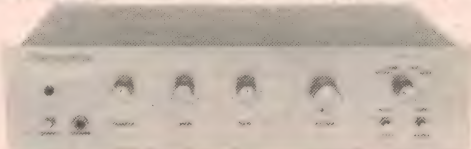
GARRARD MODEL 82**\$57.00.**

A superb 3 speed transcription changer/player Auto/manual operation 4 pole magnetically shielded syn. motor. Resiliently mounted. Counterbalanced. Elegant tone arm with slide-in cartridge carrier calibrated Antiskate. 265mm (10 1/2"). Aluminium platter Cue and pause control. Cartridge tilting lever. Magnetic cartridge diamond stylus. Size 375 x 335 x 170mm (14 1/4" x 13 1/4" x 6 1/4") 4.5kg (10 lbs) P & P **\$2.50** Interstate **\$3.50**

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MODEL—6400 3 speed auto manual changer—player 2 spindles. Motor 2 pole 240V 50Hz 10 1/2" turntable cue and pause, tubular section pick up arm, Sonatone cartridge. Great value **28.50**.

Teak or Walnut pre-cut base and fully moulded, tinted perspex cover complete with hinges suits either model. **\$29.95** p.p. **\$4.50** interstate **\$5.50**. Base only **\$14.95**. Cover only **\$14.95**.

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Kit of top quality components with c-core transformer. **\$99.95** p.p. **\$3.50**. Interstate **\$5.50**. Kit available with assembled and tested printed circuit board for **\$12.00** extra. Fully constructed ready for operation 40/40 **\$130.00**

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Top Quality, Low Cost. Phase-lock Loop system. 23 Ch. USB, LSB, AM. Power in-put, SSB 12W PEP, 5W am. S Meter. PA Facilities. Mic. mounting bracket. Book Circuit. **\$219.90**. P&P **\$3.50**.

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240V ac 50Hz. Operation. Sec approved. Fully filtered. Regulated 13.8V DC output. 1.8 amp max. **\$29.95**, 2 amp cont. **\$38.95**. P&P **\$2.50**.

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These are the very latest model. Send S.A.E. for specs. and our low, low quote.

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Low noise professional quality polyester tape. Guaranteed. Recording time 38 mins. **10** for **\$7.99**. P.P. **\$1.50**. Interstate **\$2.50**.

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Super Strong Case with Meter, leads and clips **\$24.50**. P&P **\$2.50**.

**ROYCE C-B TRANSCEIVER
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Phase Lock Loop Oscillator, 23Ch. RF Out-put 4 watts complete with Mic. send S.A.E. for full technical data

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1.55 Mts (5ft) Helical **\$15.00** Base **\$5.00** FON Rail, Road, Air.

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Model	Imp	Watts RMS	Reson. Hz	Freq. Hz	Price	P.P.	Int' state.
C8MX	15	10	45	35-20000	\$6.50	\$1.00	\$1.50
C8MX	8	10	35	35-20000	\$8.50	\$1.00	\$1.50
C80D	8	20	45	35-8000	\$11.00	\$1.50	\$2.00
C12PX	8	30	40	35-13000	\$16.50	\$2.50	\$3.50

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240 Vac 50Hz operation. In good working order and condition guaranteed. Model 908A Hi. Imp. Input (provision for Lo. Imp. Mic. Transformer, but not supplied) 2 x KT66 output valves. Output Imp. 500, 125, 4 Ohms. Power 10 Watts **\$35.00**. Model 920A. Hi. Imp. Input 2 x KT66 output valves, output, 600, 250, 150, 4 ohms, 70V line. Power 20 watts. **\$45.00** FON By Road, Rail, Air.

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DUCON .001 12KV

CERAMIC CAPS. 10 FOR **\$2.50** P.P. 60c.

AMATEUR BANDS

don Proctor. Gordon has for many years run YRS classes at 24 York Street, Gosford and records show that eight ex-YRS students are now members of the CCARC.

GOLD COAST RADIO CLUB: Manager of the club's stations, Pat Irwin, VK4FI conducts a net through the GCRC repeater VK4RGC each morning at 8.00am, and welcomes visitors to the Gold Coast who join the net. This also enables those much farther away to ascertain if weather conditions are conducive for a day at Gold Coast resorts. Amateurs in Brisbane, Dalby, Tara, Inverell, Moree, have used this service.

Each Sunday at 7.30 pm a net is conducted through the repeater until 8.00 pm when a net under the club call sign VK4WIG is conducted on 3565kHz.

The postal address is PO Box 588, Southport, Qld.

WEST AUSTRALIAN VHF GROUP (INC): The involvement of members of the group in the Wireless Hill Telecommunications Museum project, has been mentioned several times in these notes. In the April, 1977, issue of their news bulletin the proposed themes around which the display should be built were stated.

- Wireless Hill—its historical development from bushland to the present day as part of the City of Melville park system. Within this theme it should be possible to relate not only the growth of Melville City, but the importance of the original radio installation for marine communication, the involvement of the station in historical events such as the founding of the Australian electronics industry through AWA and the sinking of the German raider "Emden".
- Broadcasting and television.
- Flying Doctor Radio—a uniquely Australian development.
- Military radio, particularly as it applied to World War II.

- Amateur radio
- Space exploration
- Electronic and communication devices
- Manufacturing—components, constructional techniques etc.

The group has been collaborating with the Melville City council on the project for several years, during which time original buildings have been converted into the group's club rooms and store for large quantities of equipment donated by many organisations and individuals. Some have been restored to original condition by group members.

This is an excellent example of amateur service to the community.

WESTLAKES RADIO CLUB: Work on the club's two metre repeater installation is progressing. It will operate from the "Bar" fire tower in the Watagan Ranges, south-west of Newcastle.

The sales of the Novice Manual has exceeded 1700 copies. The furthest point in Australia that a copy has been sent is Kuri Bay near Broome, West Australia. The cost of the manual is \$3.00 post paid anywhere in Australia. Remittance should be sent to the Secretary, WRC, PO Box 1, Teralba NSW 2284.

DARWIN AMATEUR RADIO CLUB: Two issues of the club's magazine—Ground Wave—provided some interesting reading and indicates that visitors would find amateur radio flourishing.

It is reported that six metres was quite active from early November, 1976 until early January, 1977. All Australian states, New Guinea, and New Zealand were worked. Activity was generally confined between 52.00MHz and 52.10MHz. The primary calling frequency 52.050MHz with secondary frequencies 52.010MHz and 52.10MHz.

Due to the combined efforts of members, the club station VK8DA operated portable from the East Point Reserve during the John Moyle Memorial National Field Day on 12th and 13th February, 1977. Operation was from 80 to 2 metres and, for a total of 1118 contacts, 8274 points were accumulated.

IONOSPHERIC PREDICTIONS FOR JULY

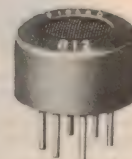
Reproduced below are radio propagation graphs based on information supplied by the Ionospheric Prediction Service Division of the Department of Science. The graphs are based on the limits set by the MUF (Maximum Usable Frequency) and the ALF (Absorption Limiting Frequency). Black bands indicate periods when circuit is open.

7.77



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Fit 7-pin miniature
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Applications include:

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Single unit price is \$9.78 (or \$8.50 + 15% sales tax)

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Complete with Electric Fan and Gas Injection Syringe.

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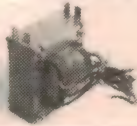
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47uF	35v	10 for \$1
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47uF	160v	5 for \$1
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SPEAKER TRANSFORMERS

7000 to 15/OHMS \$1.75
1200 to 15/OHMS \$1.75
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TRANSISTOR 7 RADIO

Complete with 3 1/2 inch speaker
No cabinet \$3.95

Speaker Systems

2CFT 40 Watts RMS \$70.00 pair.

T.V. TUNERS

Pye Eaf 002
Complete with
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B.S.R. CERAMIC STEREO

\$5

Pick up Cartridges
Universal Type

SPECIAL COLOUR TV CHASSIS & BOARDS

Some complete \$1 to \$20
Counter sales only on these items.



SUPER SPECIAL OUTPUT TRANSISTORS

AD 161
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LEVEL AND BALANCE METERS



12.000 ohm 100 Microamps \$2

SLIDE POTS 50k 4 for \$2

Special miniature transistor pots
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Special miniature tuning condensers
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SPEAKER SPECIAL

2 1/4 INCH 8/Ohm 2 for \$1.

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6AB8 \$1.50	6DB5 \$1.50	6EH5 \$1.50	1954 \$1.50
6CB8 \$1.50	6EF89 \$1.50	6C15 \$1.50	6A24 \$1.50
6BCC \$1.50	6DC9 \$1.50	6AK5 \$1.50	6V86 \$1.50
6EH5 \$1.50	30AE3 \$1.50	1T4 \$1.00	6AM6 \$1.50
UCL82 \$1.50	12AX4 \$1.50	6C07 \$1.50	6AK8 \$1.50
6AH6 \$1.50	6F39 \$1.50	6CL83 \$1.50	6DC8 \$1.50
6SA1 \$2.50	6F6 \$1.50	12A05 \$1.50	6BCB \$1.50
6B06 \$2.00	15CW5 \$1.50	6BK7 \$1.50	6B8 \$1.50
1B3 \$1.50	6AU5 \$1.50	6LNB \$1.50	6CC84 \$1.50
6BCC \$1.50	6BF5 \$1.50	19A5 \$1.50	6AN7 \$1.50
6M84 \$1.50	6EH5 \$1.50	6BN4 \$1.50	6JW6 \$1.50
12AU7 \$1.00	6ES6 \$1.50	6DB5 \$1.50	PCF802 \$1.50
6EAB \$1.50	6F41 \$1.50	6DA6 \$1.50	6CUB \$1.50
155 \$1.50	35W4 \$1.50	6DL8 \$1.50	70J8 \$1.50

PICK UP ARM BALANCED STEREO COMPLETE WITH CARTRIDGE \$9.00

Fuses 1/4 amp ... 10 for \$1
500MA 10 for \$1
10 amp pigtail 10 for \$1

SPECIAL PICTURE TUBES 17 inch 90° new \$10.00

POWER DIODES OA636 1000 v 50 cents

2E26	14.00	DL96	\$1.50
PCLB3	11.50	EAF 42	\$1.50
DM70	11.50	6SJ7	\$2.50
6SL7	12.50	25Z5	\$2.50
IM5	11.50	35	\$2.50
6U5	12.50	SP51	\$2.50
6F37A	12.50	6L18	\$2.50

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17 inch 90 deg \$15.00

TELESCOPIC AERIALS \$1.50

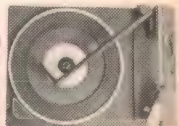
T.V. Tuner \$10

SPEAKER CABINET including 2 dual cone speakers, 6 1/2 inch 10watts RMS \$16. Size 16 1/2 x 10 1/2 x 8. Pack & post Interstate \$5 a pair, NSW \$3.00.

STEREO AMPLIFIER tuner 5watts per channel, complete ready to use, shop soiled \$25.00. Pack & post \$1.50. Interstate \$2.50.

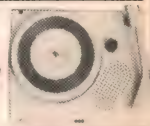
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B.S.R. Record Changer 12 inch turntable Balanced Arm cueing device etc. \$35 pack and post \$2 interstate \$2.50



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Gramophone Motor & Pickup B.S.R. 4 Speed \$7.95



Mixed Transistors 10 Different Values \$2

BARGAINS BARGAINS BARGAINS BARGAINS

Hook up wire 30 mixed colours \$1.
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50 ohm Pots ideal for ext. Speakers 50 cents. Transistor and Driver Speaker Transformers \$1.00 pair. Ferrite Rods 6 1/2 x 1/2 inch 50 cents.
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boost controls. Includes fancy chrome face plate \$10.
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250 mixed screws, BSA, Whit self-tapper bolts, nuts, etc. \$1.25 bag plus 40c post.
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5 x 7 in 8 or 15 ohm \$6.00
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8 x 4 8 or 15 ohm \$3.50
6 x 4 8 or 15 ohm \$3.50
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Magnavox 5 inch 4 ohm 8 Watt \$4.00
Magnavox 5 inch 15 ohm \$6.75
Philips Gramophone Motor & Pickup 6 volt \$5.00
Magnavox 6 inch 3 1/2 ohm \$2.50
Magnavox 5 x 3 8 ohm \$2.50
Magnavox 4 ohm 5 x 3 \$2.50

MSP 4 x 2 5 ohm \$2.50
MSP 6 x 4 47 ohm \$3.50
ROLA 5 x 7 47 ohm \$6.00
ROLA 6 x 9 47 ohm \$6.00
Magnavox 5 inch 8 ohm \$4.00
Magnavox 5 x 9 inch 3 1/2 ohm \$5.00
Magnavox 5 inch mid range 8 ohm \$6.00
Magnavox 10 inch dual cone 15 ohm \$10.00
MSP 4 or 5 inch 3 1/2 ohm \$3.50
2 1/2 inch 33 ohm \$2.00

\$2.50
\$3.50
\$6.00
\$6.00
\$4.00
\$5.00
\$6.00
\$8.00
\$10.00
\$3.50
\$2.00

Shortwave Scene

by Arthur Cushen, MBE



The changes of frequency which are made by the international broadcasters have been the subject of several questions recently from our readers. In this issue we outline the reasons for frequency changes and schedule adjustments.

From time to time new readers to this page comment on the fact that international short-wave stations (which operate for world-wide reception) make frequency changes during the course of a broadcast which forces them to look for another channel. This is a daily occurrence with many stations operating on a 24 hour a day schedule, as they are trying to serve the biggest audience at a given time, as well as trying to provide secondary coverage for most parts of the world. This is the case in the Radio Australia, BBC, Voice of America and other stations, which are often heard making frequency changes during the course of a broadcast.

The new reader becomes aware of major changes to schedules and frequencies in use, which occur four times a year: on the first Sunday in March, May, September and November.

On the first Sunday of these months seasonal adjustments are made, forced by changing reception conditions. The stations move to either lower or higher frequencies to enable them to propagate their signal to the various parts of the world to which the transmission is beamed. Though these stations submit their frequency plan to Geneva in order to try to prevent a clash of frequency and allow an orderly distribution of frequencies to be made, it does not always work out this way.

On the day of the frequency change, the monitors employed by broadcasting organizations (such as the writer) often find that the frequency allocated is not suitable because of interference from a station not authorised to use the channel. Changes have to be made and amendments notified to Geneva.

The present schedule of international stations is valid up to September 3, but there are some stations who make a change only twice a year.

The stations that offer a local or regional service on short-wave are not affected by these frequency changes, and many stations have operated on the same frequency since they first commenced broadcasting. The publication of details about these stations is usually correct at the time the information appears in print. In the case of the international stations though, it is often on the very day that a schedule frequency change comes into effect that further changes take place. This can often make published information incorrect, but of course no one has control of this situation.

Some of the recent changes that have taken place by stations serving this area are as follows:

GERMANY: The Voice of Germany has two transmissions in English for the Pacific area. The first broadcast 2100-2200GMT is on 7130 and 9765kHz, and the second 0930-1030GMT on 9650, 11850, 15275, 17715, 17780, 17825 and 21540kHz.

GREAT BRITAIN: The BBC World Service operates 24 hours a day and has three transmission periods designed for reception in this area. The transmission

0545-0915GMT is the only one with an alteration—7150, 9640 and 11955kHz now carry all transmissions. In the past, 11955kHz did not open till 0700GMT.

NEW ZEALAND: Radio New Zealand, the Shortwave Service from Wellington, has one transmission to Australia 0730-1030GMT and this is carried on 6105kHz. The broadcasts for the rest of the day are beamed to the Pacific with the transmissions 1800-2015 on 6105, 9770kHz; 2030-0050 on 11960; 2030-0540 on 15130; 0100-0715 on 11705; and 0555-1030 on 6105kHz.

NORWAY: Oslo has three transmissions, which give fair reception in this area. Frequency changes took place on May 1 to all these transmissions. The present schedule is: 0500-0630GMT on 11860, 11895, and 15135; 0700-0830 on 6015, 9590, 11850, and 15135; and 1100-1230 on 15135, 15175, and 21730. English is broadcast for the last thirty minutes of the Sunday transmission from 0800GMT onwards.

SWITZERLAND: Berne broadcast to this area 0700-0930GMT, with English at 0700 and again at 0900 for thirty minutes. The frequencies in use are 9560, 11775, 15305 and 17840kHz. This schedule is valid till November 5.

USA: The Voice of America is using two new frequencies for its transmission to Oceania. From 1100GMT they use 5955, 9730 and 15345kHz, and from 2200-2400GMT the broadcasts are on 15205, 15290 and 17820kHz.

SABC ENDS MEDIUM WAVE

The South African Broadcasting Corporation has announced the closing of all medium wave stations at the end of June and the subsequent move to FM for all their broadcasts. According to Radio South Africa, the change does not affect Radio 5, a youth orientated pop music station which will remain on medium wave and will also add relays on short-wave. The short-wave transmissions will be on the 49 or 90 metre bands using a specially constructed long periodic antenna. The transmitter will be of 100kW.

The three new 500kW transmitters for Radio R.S.A., the Voice of South Africa, for its International Service have been tested. As well, new antennas have been installed for use with the high powered transmitters.

NEW FEBA FREQUENCIES

The Far East Broadcasting Association on Seychelles in the Indian Ocean has been heard on three frequencies in the 25 metre band during our afternoons. The broadcast on 11800kHz includes gospel programs in English to 0430GMT and then broadcasts continue in Swahili. The second frequency is 11810kHz and broadcasts have been observed opening at 0315GMT in an Arabic type program up to 0345GMT.

A frequency change is then made to 11845kHz and broadcasts continue from 0345 to 0440GMT on this channel. The program on 11845kHz is to the Indian area, but signals suffer interference from Radio Canada which uses 11845kHz up to 0427GMT. The frequencies of 11800 and 11810kHz both suffer from slight sideband interference from Radio Moscow using 11805kHz. The address of FEBA is: PO Box 234, Mahe, Seychelles.

TRANS WORLD RADIO

As well as from the new transmitter at Guam, Trans World Radio is frequently heard from Monte Carlo and Bonaire. The Monte Carlo transmissions in German have been noted on Sunday 0445-0515GMT on 5965kHz with fair reception quality.

The Bonaire transmitter has a German broadcast 1000-1030GMT which has been observed on 11900kHz moving from 11895kHz. The service in English to North America is on 11815kHz at 1130GMT, according to Trevor Phillips, Porirua, NZ.

RECENT VERIFICATIONS

NORTH SOLOMONS: A verification letter has been received from Radio North Solomons, formerly Radio Bougainville. The slogan of the station means "Voice of the Sunrise", and this is used because the station is situated in the most easterly direction in Papua New Guinea.

Radio North Solomons, which operates on 3322kHz, is one of 17 stations operated by the National Broadcasting Commission of Papua New Guinea, a Government statutory organisation. Eventually there will be radio stations in all 19 provinces in the country. The verification letter was signed by Aloysius Sahoto, Station Manager, PO Box 35, Kieta, Province of North Solomons, Papua New Guinea.

YEMEN: A verification letter from Yemen was received after 20 months, and is signed by the Technical Director of Radio Sanaa. The station regretted the delay in replying to my report. The full address is the Technical Director, Radio Sanaa, Radio and TV Corporation, Yemen Arab Republic.

LISTENING BRIEFS

GERMANY: Radio Berlin International is using the new frequency of 11840kHz for the English transmission to the West Coast of North America 0330-0415GMT. There is some sideband interference from Radio Canada on 11845kHz. The German transmitter continues after 0415GMT with a program in German.

BELGIUM: Brussels has been using the new frequency of 9655kHz, having moved from 9650kHz for the broadcast in Dutch. The transmission includes frequent announcements and popular music, and is heard 0430-0715GMT.

SWEDEN: Radio Sweden has been heard operating on 11905kHz from 0000-0230GMT. The program includes English at 0030GMT, Swedish 0100GMT, Spanish 0130 and Swedish again at 0200GMT. The station closes at 0230GMT.

DENMARK: Radio Denmark in Copenhagen has altered its transmission times, according to Sweden Calling DX'ers, and now has transmissions of one hour duration. On Saturdays there is a 30 minute program called "Viewing Denmark", which is heard for the last 30 minutes of each transmission. The Broadcasts are heard 0730 (except Monday), 0900, 1200, 1400, 1600, and 1930GMT. All broadcasts are on 15165kHz.

PORTUGAL: Lisbon is being heard on 4865kHz with the interval signal at 1858GMT and opening announcement at 1900GMT. This station was at first thought to be the transmitter in the Azores, which has used this frequency for many years. The signals from Lisbon have been heard to fade out around 2130GMT.

SPAIN: Madrid has a transmission in English for Europe 2030-2130GMT, and this is repeated 2130-2230GMT. Two frequencies are used: 6100 and 9505kHz.

AMERICAS

BRAZIL: Racio Nacional at Brazilia is now using 15245kHz for its service to Europe, which also gives good reception in the South Pacific. The transmissions are at 1900 in Portuguese, 2000 in German and 2100 GMT in English. The station has the English transmission till 2200GMT, and when closing gives the address as Racio Nacional Brazilia, PO Box 04/0340 Brazilia.

UNITED STATES: KGEI San Francisco has replaced 5980kHz with 9555kHz for the transmission to Asia 0700-1000GMT. English is broadcast at 0700, Japanese at 0800 and Russian at 0900GMT. Some interference is noted up to 0800 from VOA transmissions from Wofferton, United Kingdom, while jamming at 0950GMT blocks the station's sign-off. ☛

Notes from readers should be sent to Arthur Cushen, 212 Earn Street, Invercargill, NZ. All times are GMT, add 8 hours for WAST, 10 hours for EAST and 12 hours for NZST.

INFORMATION CENTRE

PLAYMASTER CASSETTE DECK: The following is a list of questions about problems that I have come across in building the Playmaster 144 stereo cassette deck. (File 1/RA30, 31):

When the left recording level potentiometer is advanced to about 2/3 on playback into the Playmaster 143 stereo amplifier, with or without a playback signal, both meters move rapidly to about one third of FSD, the left more so than the right. Also the Playmaster 143 pilot light dims considerably and a crack is heard in the loudspeakers when this pot is advanced.

There is a lack of frequency response in one of the recording equalisation preamps. Could it be that the 0.1uF capacitor in series with the 1mH inductor is not the right value? One of these capacitors is a greencap marked 2B104. Is this capacitor 0.1uF or not?

Referring to the power supply, the +21V and -15V rails are correct but the +15V rail is 2 volts above the stated value. The 470uF smoothing capacitors are of different voltage ratings, one 16V and the other 25V and I thought this might have something to do with the dif-

ferences. If not, could it be a faulty zener diode. Will 17V instead of 15V do any harm to the op amps?

The meters I have been supplied with were registering low so I reduced the series resistors to 48k. Both meters register now but I am wondering if they are properly calibrated.

Up till now I have not been able to obtain the metalwork so I had to set the deck up temporarily. The PCB and all components was supported by four 1 1/2 inch screws and nuts. The Vortex deck was earthed, left standing on its side so that the cassette is inserted vertically. The transformer was earthed and placed in the cardboard box that it came in and the 240V/110V terminal strip placed between the transformer and the deck. The transformer does not have a copper strap. My problem is that there is considerable amount of hiss on playback when the treble control is advanced fully on my amplifier and only when the treble control is reduced to about half-way does the hisses cease. I was wondering if the absence of cabinet and copper strap would cause this hum or is it the motor inducing hiss on the R/P heads?

I have built my circuit with the modifications published in the addendum article in January, 1975. Could you also advise me where I can purchase the metalwork and front panel? (I.D., Edenhope, SA).

• Your cassette deck circuitry is evidently unstable and should not be used in conjunction with the amplifier while in this condition—otherwise there is a likelihood of damage to the output transistors.

The cassette deck should be assembled in the correct steel chassis to ensure low hum and freedom from instability.

The op amps are not likely to be damaged while running at +17V but the zener diode is probably faulty (and noisy) and should be replaced. The 0.1uF equalisation capacitor is correct.

Some meters have been supplied with 500uA sensitivity and these can be adapted by reducing the 68k series resistor. This cannot be adjusted until the whole unit is assembled into a chassis.

The deck should not be used with full treble boost from the amplifier. The tone controls should be used sensibly. Hiss is not a problem if the tone controls are set for flat treble response.

LOUDSPEAKER PROTECTOR: As a "build-your-own" hifi enthusiast I find your magazine most stimulating, with such projects as the latest Playmaster Twin Twenty-Five ranking superb. This commendation applies particularly to the power amplifier sections with their

Sanwa precision circuit testers— Big on features. Bigger on selection.



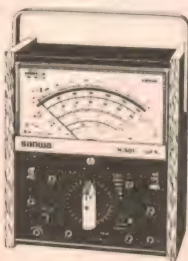
1



2



3



4



5



6



7

1. BX-505

- Fast-response, 24μA movement — fuse & diode protected with high resolution factor (0.4μA/scale division)
- Revised scale marking — intermediate readings readily determined

2. U-60D

- 44μA movement — quality performance, diode protected
- Stable ACV measurement — solid-state rectifier & enlarged frequency coverage

3. SP-10D

- Easy operation — multiposition rotary selector switch & well-lighted scale
- Stable ACV measurement — durable diode rectifier

4. N-501

- 2μA suspension movement — 0.05mA/1mV resolution
- Double protection — fuse & Si diode

5. CX-505

- 16.5μA movement — varistor protected & 50kΩ/V for DC
- Capacitor tester — push-button operation with solid-state oscillator built in

6. PDM-500 (Insulation Tester)

- Battery operated — 3 small-size 1.5V batteries built in
- Push-button operation — pointer calibration & insulation test

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MULTITESTERS

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COMPONENTS: We do not deal in electronic components. Prices, specifications, etc., should be sought from advertisers or agents.

REMITTANCES: Must be negotiable in Australia and made payable to "Electronics Australia".

ADDRESS: All requests to the Assistant Editor, "Electronics Australia", Box 163, Beaconsfield, 2014.

complete independence from aluminium electrolytics (the 22uF feedback capacitor can be a tantalum type).

The associated speaker protector goes a long way towards relieving me of my diffidence over direct-couple outputs too but I query the user of the large 47uF filter capacitors which by my calculations give about 0.25 sec delay of cutout in the event of a transistor blowout. Are you able to assure me that the average 20W-plus speakers can stand this overload?

Could you also explain why much smaller capacitors than the 47uF size would not suffice? Once again thanks for a great amp and the numerous other projects of yours I have built. (I.B., Christchurch, NZ)

• First, the loudspeakers can withstand a short term overload although ideally it should be minimised. In theory, smaller capacitors should be adequate and would give faster overload protection. In practice smaller filter capacitors can lead to relay jitter when the amplifier is handling low frequency, high amplitude signals. We regard the value we chose as a suitable compromise.

NOTES & ERRATA

AUTODIM (January 1976, File No. 2/PC/21): To ensure correct operation in the automatic mode it is essential that the 2500uF capacitor be fully formed. If necessary, remove it from the circuit and connect it to a DC voltage source (lower than its voltage rating) in series with a 1k limiting resistor. Allow to form for at least 10 minutes, then discharge and replace in circuit.

OP-AMPS WITHOUT TEARS-5 (April 1977, File No. 8/DT/105): P.74, Fig. 35: R3 = 90k, 1%. P.77, Fig. 38: R4 = 990k, 1%; R5 = 323k, 1%; R6 = 90k, 1%; R7 = 23.3k, 1%; R8 = 0. The meter resistance should be less than 1% of R9 or alternatively the total resistance of R9 plus the meter should equal 10k.

SWR METER (April 1977, File No. 7/SW/9): The circuit on page 34 is in error, in that the anode of each diode should go to the other end of the respective 82 ohm resistor. The wiring diagram on page 37 is correct.

MINI FREQUENCY COUNTER (May 1977): On the circuit diagram on page 57, IC9 was incorrectly listed as type DM7492. The correct type number is DM75492.

27-28MHz PREAMPLIFIER (May 1977, File No. 2/SW/67): Pin connections for the MPF131 FET are identified by a dot adjacent to pin 1, viewed from above. Also, the "power on" LED polarity is shown reversed on the PC board diagram.

printed circuit

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ET444S	3.00	ET316	2.50	ET549A	2.50
548	3.20	77TTY6	2.50	HMS276	6.00
77PTY7	2.80	77PTY6	2.50	ET133	2.60
77E05	3.50	77TRE5	2.50	77UP5	8.50
ET081	2.20	ET062	2.50	ET546	2.50
ET632U	4.00	ET632	7.00	77TTY4	2.50
77CC4	3.00	77UP2	3.00	ET132	2.50
ET632C	8.00	ET632B	6.50	ET632A	6.50
77UT2	3.00	77F18	2.50	77F1A	3.20
ET633FR	6.00	77UT2	3.00	ET633	6.00
ET632P	2.50	ET632M	7.50	ET482B	2.80
ET482A	6.50	76CL12	2.50	ET630	2.20
76B4	2.60	ET480PS	2.50	ET480	2.80
ET631	7.00	ET630	2.20	ET066	2.20
ET064	2.00	ET449	2.20	ET804	2.80
ET448A	2.20	ET448	2.80	ET711C	2.00
ET711B	2.20	ET068	2.00	ET061	2.00
ET044	2.00	ET043	2.00	76M19	3.50
ET711R	2.50	ET711D	6.00	ET447	2.80
ET544	2.50	76PC9	4.40	76EX10	2.80
ET602	6.50	ET446	2.50	ET533A/C	3.50
ET711A	7.50	ET543B	2.50	ET543A	2.50
ET445	2.50	ET241	2.80	ET780B	2.50
ET780A	3.00	ET541	2.50	ET444	2.50
76S7	2.50	76M17	2.50	76LM5	2.50
76SS6	3.00	76SW4	2.00	76R4	2.50
76M5	2.50	76VG5	5.00	76E04	3.00
76VG5	5.00	76M5	2.50	76R4	2.50
ET708	2.50	ET740A	4.50	ET740B	3.50
ET514	2.50	ET707A	2.50	ET707B	2.50
ET706	2.50	ET130	2.50	76RT3	3.00
76T2	2.50	76A03	2.50	76G3	2.50
76E02	5.50	75SWILA/Bpr4.00	DRS-RC1	4.00	
75PC12	2.50	EA78F1	2.80	ET534	2.50
ET514	2.50	ET129	2.50	ET28	2.50
ET439	3.00	ET420G	2.50	ET123B	2.50
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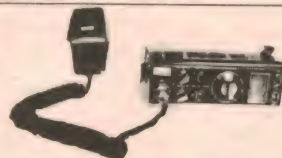
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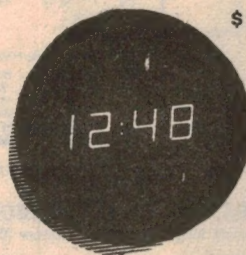
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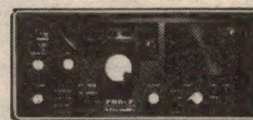
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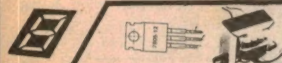
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205	500, 600	1077	0-15-20, 0-15-20	8.20
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WHY YOUR NEXT CASSETTE SHOULD BE A MAXELL UD



3 THE SHELL — Even the best tape can get mangled in a poorly constructed shell. That's why Maxell protects its tape with a precisely constructed shell, made of lasting heavy-duty plastic.

No fixed guide posts are used. Instead Maxell uses nylon rollers on stainless steel pins thus eliminating the major cause of skipping, jumping and unwinding.

A tough teflon (not waxed paper) slip sheet keeps the tape pack tight and flat. No more bent or nicked tape to ruin your recording.

Maxell doesn't use a welded seal, but puts the cassette together with precision screws. Result — Maxell doesn't jam.



1 THE RESEARCH — More than twenty years ago, Maxell produced their first reel of magnetic tape. At that time, Maxell made a commitment to produce and sell only the finest magnetic products their technology could create.

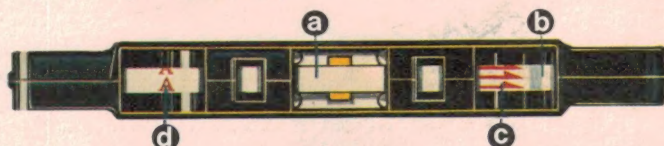
That commitment still stands today.

2 THE TAPE — This continuous research has lead to the development of the Maxell UD (ultra dynamic) cassette. A tape that has a coating of super-fine PX gamma ferric oxide particles with an extra smooth mirror-finish surface.

All of this adds up to high output, low noise, distortion free performance and a dynamic range equaling that of open reel tapes.

4 THE LEADER — A leader tape that has a four function purpose.

- a) Non-abrasive head cleaning leader (cleans recording head for 5 secs.).
- b) 5 second cueing line (recording function starts 5 seconds after the line appears).
- c) Arrows indicating direction of tape travel.
- d) A/B side mark (indicates which side is ready for play).



Now you know why your next cassette should be a Maxell UD (ultra dynamic).

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The sound expert's cassette. UD available in C60, C90 and C120. Distributed by **Hagemeyer (Australasia) B.V.** Branches in all States.

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Features JVC-JRS600 FM/AM TUNER (illustrated) With 5-way SEA: tape dubbing: hi and low filters: THD 0.1%: FM noise reduction circuit: 110 watts minimum per channel RMS: FM sensitivity, 1.7uV: signal to noise ratio, 65dB (Stereo): AM suppression, 55dB: stereo separation, 1KHz-50dB: alternate channel selectivity, 80dB.

Others in the JR-S range: JR-S400 — 70 watts per channel RMS minimum. JR-S300 — 50 watts per channel RMS minimum. JR-S200 — 35 watts per channel RMS minimum. JR-S100 — 20 watts per channel RMS minimum.

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